The science news monthly

SCIENCE DIGEST

FEBRUARY 1965 35 CENTS ICD

New evidence of LIFE ON OTHER WORLDS

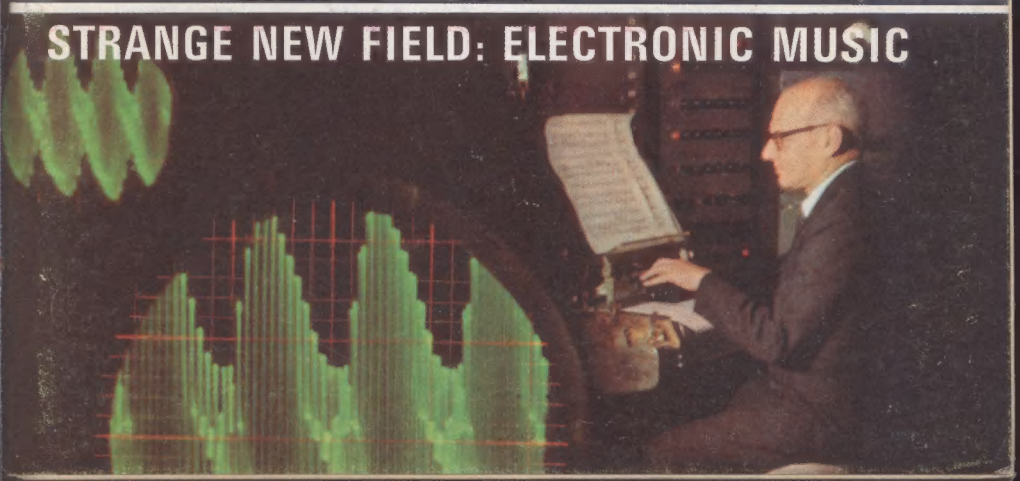
What to do about unbearable pain

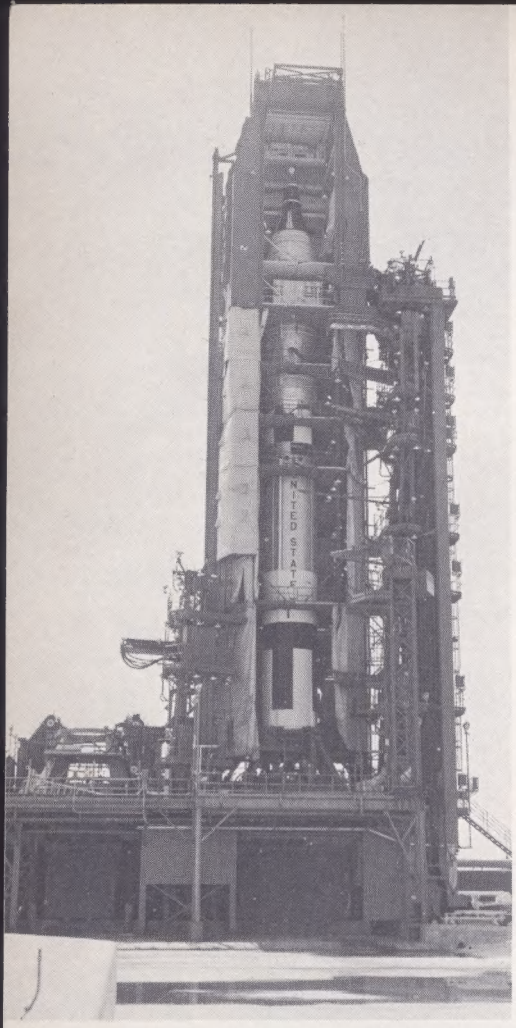
CALIFORNIA'S SCIENCE 'MONOPOLY'

OUR SENSE OF HUMOR
A hilarious psychological test

Teen-age antics: world-wide scare

STRANGE NEW FIELD: ELECTRONIC MUSIC





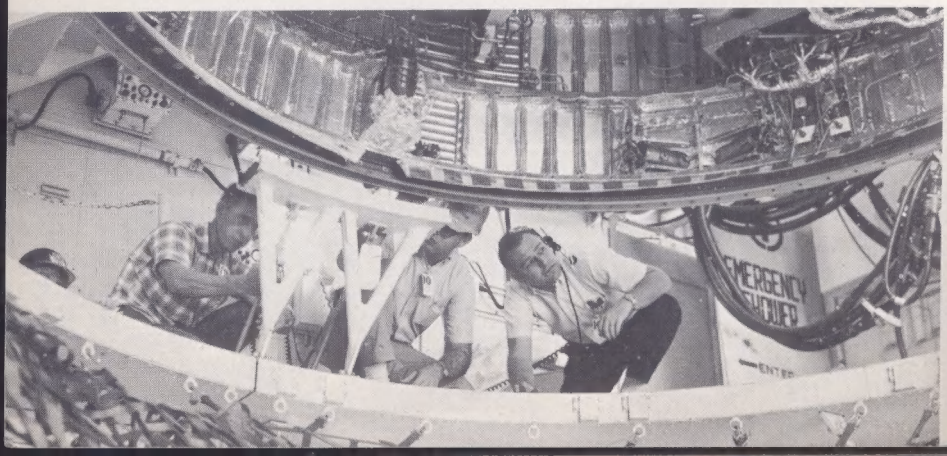
Rehearsal for Gemini

PRELIMINARY tests last year for the two-man Gemini spaceflight ran into technical difficulties which have set the project several months behind its original schedule. However, National Aeronautics and Space Administration officials confidently expect to have astronauts "Gus" Grissom and John Young in orbit shortly.

The first Gemini test, April 8, 1964, was the launching of a full-scale model capsule, which orbited the earth three times. It burned up on re-entry because it had no heat shield. The second test, planned for December, 1964, was to test the heat shield as well as control, life support and other systems. But this attempt had to be shut down less than two seconds after ignition because of a failure in the hydraulic system.

NASA Photos

Left: Gemini spacecraft and Titan II launch vehicle are readied at Cape Kennedy. Below: Scientists watch as spacecraft is mated to top of Titan rocket—total height is 190 feet.



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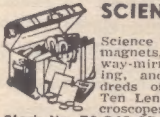

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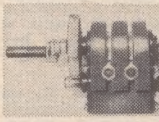

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IS THERE a fifth force in the universe? Physicists think there may be. They have been making a concentrated effort during the past two months to see whether there is.

If the answer is yes, a lot of textbooks on physics are going to have to be rewritten. And even if the answer is no, they will have to be. The reasons (and just what the fifth force means) are explained in the article starting on page 37.

The story of this possible new breakthrough in physics typifies the dizzying pace at which we're adding to our knowledge.

THIS MONTH

What is even more dizzying is the pace at which new scientific developments transform our way of living —the money we make (or don't make), the cities we live in, the way they grow (or don't grow) and the complex of material paraphernalia that plays a part in almost every moment of our daily routine.

For a glimpse of how that happens, we suggest you turn to page 22 and read how science has transformed California, or to page 61 and read how computers have evolved into a third "generation" since the "species" originated 15 years ago.

Every month in *Science Digest*, we attempt to report and explain the key news in science. This month, it seems to us, the news is as vital—and exciting—as ever.

THE EDITORS

SCIENCE DIGEST

Twenty-ninth year of publication

Photo by Bruce H. Frisch

Electronic music does not mean the takeover of music by the machine. New techniques give composers more freedom, some upon hearing electronic music for the first time, say too much freedom. But like it or not, you will be hearing more of it. See the story beginning on page 72.

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THE LATE SCIENCE NEWS

ENIGMATIC RANGER 7 PHOTOS. Astronomers studying those crystal-clear closeups the Ranger 7 satellite took of the moon are not learning very much. Those who previously thought the lunar surface was covered by a deep dust layer point to the small craters with softly rounded edges shown in the photos as evidence to support their view. Those who thought the dust layer was thin also use the photos for support. A similar contradictory interpretation of the photographs has taken place among those who favor and oppose the theory that the moon's surface was formed by lava flows. Ranger was a technical marvel, but its scientific value is questionable.

MARINER 4 ON TARGET. Mariner 4 is well settled into its 228-day cruise to Mars. Corrections early in the flight were so accurate that the probe will pass within 5,400 miles of Mars, a mere 1,000 miles from the bullseye aimed at when the craft was launched. Considering the whole trip is 325 million miles, Mariner's accuracy is fantastic. It will be well within range for its television camera to take useful pictures of the planet's surface. However, project directors are not sure the camera will be aimed in the right direction when the time comes. The camera aiming system has run into some unforeseen problems, and methods of assuring proper aim from earth are delicate and tricky.

SILENCE ON ZOND 2. Following Mariner through space is a Soviet Mars probe, Zond 2. Shortly after launching, the Russians announced that their probe had developed only half its intended power supply. This would mean the probe could not communicate information over the vast distances between earth and Mars. Since then, the Russians have said nothing.

MISSION TO MARS NEXT? The Space Science Board of the National Academy of Sciences recommended that unmanned exploration of Mars be the next big space goal after the manned Apollo moon shot. This would mean downgrading other manned space activity such as an extended exploration of the moon and an orbiting space station. The board sees the possibility of sending men to Mars by 1985.

NEW LIFE FOR NIMBUS. The Nimbus 1 weather satellite was orbited last Aug. 28. It ran into trouble right from the start. Its orbit was the wrong height and shape. Then on Sept. 23 it lost all its power and stopped working. But when technicians made a routine check on Dec. 8, they found it was still alive. The pictures it was transmitting were poor but it is expected to send engineering information useful for future Nimbus flights.

APES SURVIVE VACUUM. Chimpanzees have survived and performed well in an almost total vacuum for over two minutes, tests have shown. The tests being conducted by the Aeromedical Research Laboratory give hope that astronauts could survive the puncture of their vehicle long enough to get the hole plugged.

LIFE ON VENUS? Scientists at Johns Hopkins University believe that conditions are favorable for life on Venus. They cite balloon observations that the clouds covering Venus are made up of ice and the air above the clouds has water vapor. Where there's water, they contend, some of it must be broken up into hydrogen and oxygen. An atmosphere with water vapor and oxygen would constitute an excellent environment for the development of life. They discount findings of the Mariner Venus probe that indicated the temperature of Venus is 800 degrees, far too hot for life. Mariner, they say, may have been measuring lightning in the planet's turbulent atmosphere.

SONIC BOOM WOES. An FAA deputy administrator was showing a group of reporters around a group of structures built at White Sands, N.M., to test the impact of sonic booms. Just as he was telling them how many persons who claimed their property was damaged by booms had only imagined the damage, a pilot accidently broke the sound barrier a mere 500 feet overhead. The resulting boom shattered windows and shook the test building to its foundations. The official, Gordon M. Bain, recovered quickly and pointed out that the wave, which was calculated as having a force of 40 pounds per square foot, was far greater than SST planes would ever create under normal conditions.

U.S. TO AID WITH CONCORDE? Instead of dropping the joint Anglo-French project to build the SST Concorde, the British are now trying to get France to slow down the plane's development and seek American participation in the work.

ALL WEATHER LANDING FOR JETS. A system that would allow jets to land perfectly without the pilot's touching the controls was demonstrated successfully at Dulles International Airport in Washington. The system, developed by Lear Siegler Corp. of Calif. and Sud Aviation of France, "locks on" to the regular instrument landing system at airports. United Air Lines is planning to install the system in all its jets by 1967. All major airports are expected to have new instrument landing equipment within three to five years. This means, according to the FAA, landings could be made at zero ceiling and visibility, eliminating many cancellations and delays that now plague airlines.

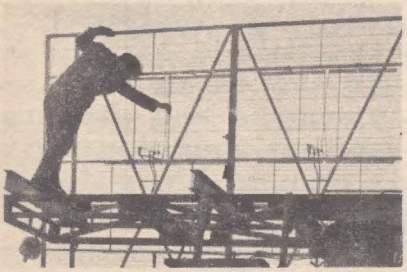
CHINA SAYS IT CAN DELIVER A-BOMB. The Chinese Communists have put the world and particularly their neighbors in Asia on notice that "conventional weapons can launch nuclear bombs as well as the intercontinental ballistic missile. An ordinary aircraft can carry them as well as strategic bombers." China is trying to stress she has immediate if limited means of delivering her newly developed A-bomb.

REMEMBER MOHOLE? That once highly publicized project to drill through the earth's outer crust has been out of the news for a long time because of a mass of technical, financial and organizational difficulties. But survey work has finally been completed and a decision on the final site for drilling may have already been made. It will probably be either off the island of Antigua or near the Hawaiian Islands.

(Continued on page 100)

THE ASTRONOMY STORY

New evidence of intelligent life on other worlds



SovFoto

A radio telescope at the Burakan Observatory, Armenia, where Soviet scientists held a major meeting on life on other worlds.

Two points on star charts, known only by their catalogue numbers, CTA-21 and CTA-102, may be the sites of fantastically advanced civilization. What's more, they may be trying to get in touch with us.

This idea was proposed recently by Nikolai S. Kardashev, a Soviet astronomer. A wild speculation? Perhaps, but none of his colleagues are saying he is crazy.

Kardashev made his proposal in the highly respected journal, *Astronomichesky Zhurnal,* and he gave full credit to the ideas of the many Western astronomers who have done a great deal of thinking about intelligent life on other worlds during the past few years.

Kardashev noted that in 1963, astronomers R. G. Conway of the Radio Astronomy Observatory at Jodrell Bank, England, K. I. Kellermann of the California Institute of Technology and R. J. Long of Cambridge University, England, had singled out CTA-21 and CTA-102 from among all the radio sources that dot the sky as "worthy of special mention."

What's so special about these two sources? First, the sources of the radio (microwave) emissions are optically invisible, that is, they are either too small, too dim or too far away to be seen with the best earth-bound telescopes. Secondly, the waves originate from tiny "points" in the sky rather than from large expanses of gas as is typical of many radio stars.

But most important, the spectrums of the radio emissions themselves are unlike any others that have yet been found in the heavens, and they are close to what scientists consider the optimum frequency for communication between stars.

The peak intensities from both sources is around 900 megacycles. This is the frequency least likely to undergo distortion or interference on an interstellar mission or to be drowned out by natural sources of microwaves.

Kardashev compared the spectrums of a hypothetical artificial source that he believed would best convey messages between stars with

the spectrums of emissions from CTA-21 and CTA-102, the correlation was not quite perfect, but it was much closer than from any other sources yet discovered.

Kardashev's boss, Prof. Iosif Shklovsky, one of Russia's best theoretical astronomers, once proposed that an advanced civilization would attempt to reach others among the stars by using a powerful radio beacon, emitting the same sort of microwaves coming from CTA-21 and CTA-102. This theory is also supported by many U.S. scientists.

Kardashev postulated three levels of civilization, on the basis of the power they can generate.

Type One, like the earth, can generate around 4,000 billion watts of power.

If the rate of power output of the earth continues to grow from 3 to 4 percent a year, as it has for the last 60 years, in 3,200 years earth will be a Type Two civilization; one that can produce roughly 400 million billion billion watts—roughly the output of the sun.

A Type Two civilization, Kardashev believes, would have enough energy to spare to build beacons that would radiate like CTA-21 and CTA-102.

Kardashev took note of a 1959 proposal of Dr. Freeman G. Dyson of Princeton's Institute for Advanced Studies, one of the world's most "way out" thinkers. Dr. Dysen thought a highly advanced civilization would be able to redistribute the matter in its own solar system so as to enclose the parent star. Thus the civilization would be able to use all the star's energy.

Such a system would not be optically visible, and could be located only at infrared wavelengths, since the outside of the system would be warm. CTA-21 and CTA-102 seem comparable to such systems, Kardashev says.

Type Three civilizations, as postulated by Kardashev, really overwhelm the imagination. They would produce 40 billion billion billion billion watts—the output of an entire galaxy.

"Quasars"

Kardashev stopped short of suggesting that "quasars" (see *Science Digest*, Sept. '64), those enormously powerful sources of radio emissions that seem to lie beyond the known limits of the universe, might be Type Three civilizations. But he did draw attention to the intense interest that has developed concerning these mysterious bodies. He also said Type Two civilizations might be common in our own galaxy.

Dr. Shklovsky and his associates have often made suggestions about extraterrestrial civilizations. Now it seems that detailed discussions have become completely respectable for all Soviet astronomers. Late last year, a conference on "extraterrestrial civilization" was sponsored by the Armenian Academy of Sciences at the Burakan Astrophysical Observatory. Host for the conference was Viktor A. Ambartsumian, the Soviet Union's top astronomer and

Only the most daring thinkers consider interstellar travel, but most scientists are serious about interstellar radio communication.

one of the best-known astronomers in the world. Ambartsumian headed the International Astronomical Union for three years.

Science fiction?

The same sort of thing happened in the United States in 1961. In November of that year, the very respectable Space Science Board of the National Academy of Sciences convened a conference on "Intelligent Extraterrestrial Life" at the National Radio Astronomy Observatory in Green Bank, West Va. Up to that time, the subject had been almost solely the province of science-fiction writers. Scientists, who are often touchy about their status, were afraid to discuss the subject too openly, no matter how interested in it they were. In his new book, "We Are Not Alone," the story of the search for intelligent life on other worlds, Walter Sullivan, science editor of *The New York Times,* says of the conference, "While it was not held in secret, in the official sense, every effort was made to avoid publicity because of the sensational nature of the question discussed."

Since 1961, the subject has come to be considered a fruitful area of investigation by scientists in many fields.

Only the most daring thinkers, like Dr. Dyson, talk about the possibility of actual interstellar travel. Many others believe that the distances and times involved are simply too great. But radio contact is quite another matter. The U.S. invested money as well as scientific talent in the short-lived Project Ozma, an attempt to pick up messages from other worlds with the radio telescope at Green Bank. The fact that Ozma was discontinued before anything was found was not discouraging. Even the most enthusiastic astronomers know that it would take scores and perhaps hundreds of years before an adequate survey of the sky could be made. Ozma was just a start. Dr. Shklovsky has suggested the Soviets now begin a project similar to Ozma.

Super-civilizations

What if we definitely establish that the emissions from CTA-21 and CTA-102 are beacons of super-civilizations? There still remain enormous difficulties in trying to understand the messages being sent. And because of the distances involved, we probably would not be able to establish two-way communication within this century.

But the mere discovery that there was someone out there trying to get in touch with us would be one of the most thrilling events in the history of man.

INVENTIONS
PATENTS
PROCESSES

Enough power to run Chicago

The TRIGA research reactor has a power level of 6,500,000 thermal kilowatts.

A NEW record for the routine controlled release of nuclear energy has been established by a TRIGA research reactor in split-second "pulsing" tests that carried its power level to nearly 6,500,000 thermal kilowatts. The record was announced by General Atomic Division of General Dynamics.

During the few thousandths of a second that one of the multi-million-kilowatt pulses lasts, before the TRIGA automatically shuts itself down, the reactor's rate of energy production—translated into electrical kilowatts—is greater than that of Grand Coulee Dam and equivalent to all the electric power required by a city the size of Chicago. The TRIGA is designed for research, testing and training, and its energy is not converted into electric power.

Repetitive, self-limiting pulses of such high power as those demonstrated by the TRIGA, with their controlled release of correspondingly high-level neutron and gamma radiations, have never been possible before in a commercial reactor that could be operated routinely with complete safety in a research laboratory. Personnel are able to work on experiments in the immediate area during the pulses.

The TRIGA's power rises from a few watts to more than 6-billion watts and restores itself to a normal operating level, all in the space of about six thousandths of a second. This occurs without use of control rods or other mechanical or electronic devices to shut down the nuclear chain reaction.

In the brief interval of one of the high power pulses, a lightning-like flash occurs in the reactor's nuclear core which is clearly visible beneath 22 feet of water. The flash is accompanied by a brilliant, slowly fading blue glow known as Cerenkov radiation which occurs when charged particles travel through water at a velocity exceeding that of

the speed of light in the medium.

General Atomic scientists said the ultra-high pulsing capability demonstrated by the TRIGA will enable scientists to gain valuable new knowledge about the effects of high intensity radiation, and will enlarge the scope of basic research in the physical and biological sciences. Applied research and testing will be extended in many areas of industry, agriculture and medicine.

Instant maps

The U. S. Army has awarded a $344,881 "follow-on" contract to Harris-Intertype Corporation for the manufacture of electrostatic printing equipment and materials.

The order calls for two five-color map printers to be built at H-I's Research Center for shipment next year. Included in the order are electrostatic paper and toners. The lightweight machines will be mounted on standard G. I. truck vans for rigorous field testing.

Electrostatic printing equipment for military maps is rapid and highly portable.

The mobile machine's ability to print "instant maps" eliminates the necessity for pre-printing and worldwide storing of quantities of quickly outdated maps, and the warehousing of map-drawings and printing plates.

Electrostatic printing is currently one of Harris-Intertype's major research programs.

The printer employes high-intensity light and electrostatic energy to create 22½ x 30-inch military topographic maps direct from 70mm microfilm in the standard map colors at a rate of 2,000 or more an hour.

The maps are printed on a moving web of specially coated paper, and cut automatically into sheets and pile delivered. Register is accurate to plus or minus five-thousandths of an inch.

New coast-to-coast communications system opens

An unusual coast-to-coast telephone call, the first official cross-country voice communication by Western Union microwave, signalled the opening of the company's new $80,000,000 transcontinental microwave system.

"This new microwave system," said Western Union President Walter P. Marshall, "can handle all types of record and voice communications at high speeds and in large volume."

Extending from Boston, New York and Washington to San Francisco and Los Angeles and serving major population centers and de-

fense installations in 23 states and the District of Columbia, the 7,500-mile microwave system is the longest single microwave project ever undertaken at one time.

The network consists of 267 microwave stations spaced 25 to 30 miles apart, which for reasons of national defense are routed to bypass critical target areas. It also provides the nation, for the first time, with a second, separate transcontinental network of broadband facilities geared to modern high-speed communications requirements and available for use in any emergency.

Designed total capacity of the microwave beam system is approximately 7,000 voice channels. It is being initially equipped to provide 600 voice bands which will add a basic capacity of more than 80 million telegraph channel miles, or more than 15 times the company's existing channel mileage.

Strongest magnetic fields

The strongest continuous magnetic fields yet generated by man have been achieved by scientists at the National Magnet Laboratory, Cambridge, Massachusetts, using a giant water-cooled magnet.

Achievement of record fields of up to 255,000 gauss was announced by the Air Force Office of Scientific Research and the Massachusetts Institute of Technology.

Highest fields previously reported were on the order of 152,000 gauss, first achieved some two years ago.

Experimental apparatus is mounted atop the record-setting water-cooled magnet.

Gauss is a unit of measurement of magnetic field intensity. The natural magnetic field of the earth, for example, measured at the surface of the earth, is about one-half gauss.

According to a National Magnet Laboratory spokesman, this magnet opens a new era of high magnetic field research in a variety of physical science areas—including the magnetic, optical, electronic, nuclear and other properties of matter. It is expected that this magnet will become an extremely powerful tool in probing the behavior of electrons and nuclei in numerous important crystalline solids and in investigating the properties of superconductors when placed in high magnetic fields.

The record-setting NML instrument is basically a solenoid magnet in which the field is boosted by inserting small pieces of iron in the core.

In its simplest form, a solenoid magnet is merely a coil of wire through which electrical current

passes. A magnetic field is induced by the current flow and the field is most intense at the center of the core of the coil.

Unlike conventional low-field iron magnets, a magnet that must generate as intense a field as 255,000 gauss makes some use of iron but must generate most of the field with very powerful coils carrying enormous currents.

The 56,000 amperes of current used in the magnet create power densities of 500,000 watts per cubic inch and pressures exceeding those at the deepest point in the ocean, 60,000 pounds per square inch.

The copper coils would melt if not cooled by hundreds of small passages carrying water under high pressure, and would be crushed by the enormous forces if not supported by steel pieces placed between every turn of the coil.

Dating seawater

A new technique for measuring naturally-occuring radioactive silicon in the oceans' waters should help oceanographers who are trying to chart the circulatory and mixing patterns of the seas' depths.

Dr. David R. Schink, assistant research professor of oceanography at the University of Rhode Island, reported that he had successfully developed and tested a method whereby he is able to remove some two ounces of silicon from more than 40 tons of sea water taken from various selected depths.

About 10 out of every billion, billion atoms in this sample is radioactive silicon-32, an isotope of the element which is formed by cosmic rays bombarding the upper atmosphere.

Since the rate at which silicon-32 decays is known within broad limits, Dr. Schink's measurements give an indication of the "age" and the movements of the ocean's waters.

Expansion of such knowledge is vital to scientists who are concerned about the dispersal of radioactive wastes in the oceans, Dr. Schink explained. Interest in his findings has also been shown by the Navy, which is supporting his work through the Office of Naval Research.

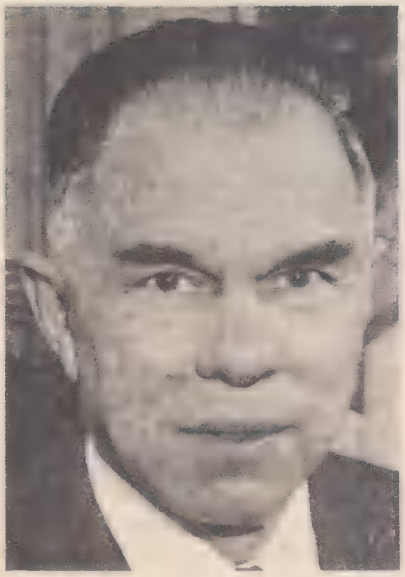
Key item in Dr. Schink's process is what is considered to be the world's largest bag water sampler, capable of collecting 10,000 gallons in one dunking.

The rubberized-nylon bag is lowered empty into the depths using, a large shipboard winch and A-frame. At a pre-set depth, a hydrostatic device opens the nine-foot mouth of the bag. As it starts to come up, water gushes through a 15-foot neck of funnel into the bag itself, which is nearly 28 feet long.

When filled, the bag turns over to disengage the funnel and is hoisted to within 50 feet of the ocean's surface. Here a suction hose and pump run the collected water through an extraction system where the silicon—in the form of dissolved silica—is captured or scavenged out, using a specially treated ion-exchange resin.

INVENTOR OF THE MONTH

Two new elements—two patents



GLENN T. Seaborg is entitled to be addressed as Doctor, if anybody is. He has 19 honorary doctorates in addition to the degree he earned in chemistry at the University of California.

Among his many distinctions, *Science Digest's* Inventor of the Month is likely to hold the record as the only patentee of an element. He recently received two such patents, for elements 95 and 96, americium and curium. Both patents are assigned to the Atomic Energy Commission, of which Dr. Seaborg is chairman.

Elements found in nature, such as gold and silver, are not patentable under the law. The synthetic elements could be patented, but all those identified so far except americium and curium have been described in technical papers, and have lost their legal novelty.

Although loaded with honors, including the Nobel prize and the Enrico Fermi award, Dr. Seaborg does not let them weigh him down. He recalls in his recent book, *Man-Made Transuranium Elements*, that during the long efforts to separate them a laboratory associate referred to americium and curium as "pandemonium" and "delirium."

He also notes that the first public announcement of the two elements was made in 1945 on the Quiz Kids radio program.

The world learned of the existence of plutonium, of which Dr. Seaborg was co-discoverer, through the bomb dropped over Nagasaki. Although recognizing its power and usefulness, Dr. Seaborg often describes element 94 as ornery and poisonous. He recently explained to an A.E.C. audience that the symbol Pu was selected, "for the reason you would suppose."

The discovery of americium and curium has scientific signifcance as marking the first breakthrough, after plutonium, in the artificial production of elements.

The Patent Office Board of Appeals denied them patents on the ground that their discovery had been anticipated by production in an early reactor. The U.S. Court of Customs and Patent Appeals reversed the decision. Patents 3,156,523 and 3,161,462 were issued accordingly.

—Stacy V. Jones

Teen-agers: New world problem

by David Alan Ehrlich

IF THE average American parent winces at teen-age antics and just can't wait for his children to outgrow the rock and rolling age of rebellion, it may be some comfort to know that it's now a world-wide problem.

Authorities see major forces at work, even in "emerging" countries, spreading the phenomenon that was first known in American cities and towns.

So governments, aware that teens are the future citizens, leaders and technicians, are showing increasing concern over their well-being.

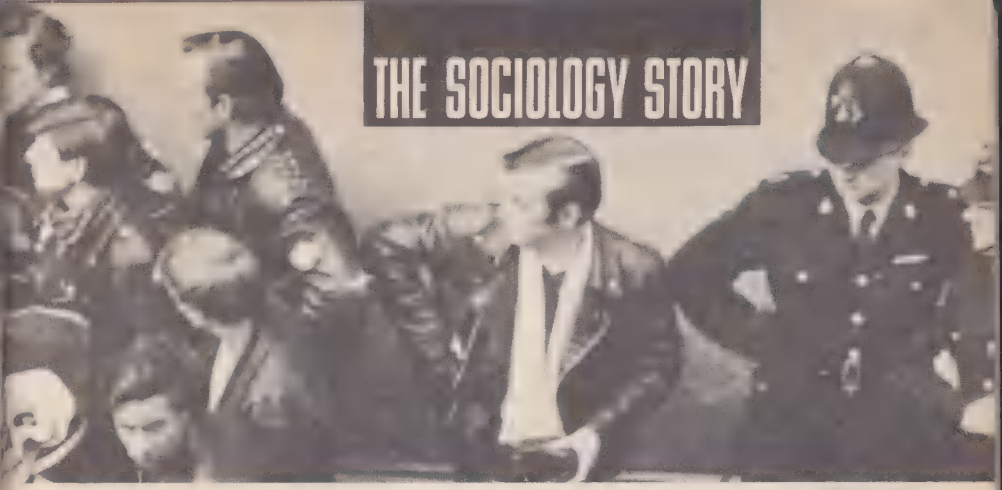
Now the World Health Organization has decided it must devote some of its resources to the teen population. For the first time, WHO has held an expert conference on adolescent health in Geneva, Switzerland. It is expected to draw up a program in 1965 for international research and the training of adolescence doctors and will ask member countries for money to support the effort.

When you talk to doctors and behavioral scientists you're struck by the similar way they see things despite their historically, richly diverse cultures.

"Until now, we didn't even have 'adolescents' as a distinct group," says a leading African psychiatrist, the brilliant young Dr. T. A. Lambo of Nigeria.

"In tribal societies, children become adults overnight, without a transition stage. Today, the old tightly knit group is breaking up. People are moving to cities, working in industry, dividing families or living pretty much alone. The social controls are diffused, from the family and tribe to those vast, often impersonal authorities: police, schools and government agencies.

"Nobody can really enforce anything. So we, too, are beginning to



Wide World

Leather-jacketed "Rockers" and their girl friends stand outside court in Margate, Kent, England. About 50 youths were arrested in the resort town last summer after an outbreak of violence and vandalism that shocked the British and made world-wide news.

see the problems of delinquency, drinking and even vice. There's also a new emphasis on material acquisition."

New urban areas lack facilities for teens. Nigeria, shaping up as an African model and center for health and scientific training, is working on American-style national youth camps, aptitude testing, vocational schools and farm settlements for youngsters who prefer to stay down on the homestead.

Dr. Lambo cautions, however, that there's a lot to preserve from the old way of life—family ties, moral values and a sense of responsibility.

In Western Europe, doctors are taking a new look at the adolescent. Despite all the popular hand-wringing about teen-agers, it seems, medicine hasn't done much about them—or for them.

Dr. Louis Christiaens, France's foremost authority in this field, deplores the fact that everyone showers attention on tots, "poor little darlings," but after 14, when the teen needs help the most and has a special "vulnerability" because his heart is working hard, he is largely ignored.

Dr. Christiaens is especially sympathetic to the handicapped teen who needs special therapy, re-education and support. He cites neglected partial blindness, whose incidence he estimates at 1 per 1,000, as well as mental retardation and motor and speech impairments.

He believes the fault is with "social organization" more than with doctors or parents, who have a strong group in France and are promoting teen centers. "It's a collective conscience defect," he says.

French pediatricians, like Americans, are stepping up their training in adolescence medicine. Many good ones are beginning to specialize in it.

Communist countries, too, are having rising problems with teen-age drinking and speeding. Prescription: Treat teens as a crucial age.

The most important thing for the teen-agers, says Dr. Christiaens, is to have "a sense of dignity," which can come only from strong family identification.

American and British doctors are particularly concerned about the advancing age of puberty. Girls are physically maturing earlier, with an average down to 12½ in the U.S. and 13 in Britain. Dr. Douglas Hubble, director of a children's center in Birmingham, England, says girls are even turning up in clinics at 8 or 9.

Liberalize the law

Analyzing the social consequences, he thinks Britain might lower the age of consent from 16 to 15 and liberalize the abortion law.

He believes that many girls are responsible enough mentally as well as physically so that men should not be imprisoned for relationships with them.

A new abortion law, he feels, might define acceptable reasons more clearly, covering the prospective mother's health, suspected malformations as in cases of German measles and notably, girls victimized by rape or incest.

"People are not agreed on the 'social' reasons," he points out. "Incest is social, of course, but it's mostly a genetic question, of mutant genes."

Personally he does not believe the law should go as far as to permit abortions freely for teen-agers.

How far puberty can advance is anyone's guess, he says, but he doesn't think much further. Doctors can't explain the reason for it, but they think it's due to better nutrition. (The notion that girls mature incredibly early in some parts of the world, because they marry at early ages, is untrue.)

In communist countries, although they claim their society produces healthier people, reports indicate rising problems with teens: difficulties in studies and some drinking and speeding, if not outright criminal delinquency.

Czechoslovakia's eminent lady Dr. Jirina Cizkova, long a keen researcher of adolescence, reveals some interesting statistics. While America's suicide rate is much higher for girls, it's higher for boys in her country. Girls get sick more often but more boys die, because of auto accidents.

She has found a new problem of peptic ulcer among teens, due to "conflicts of school, job and love." Doctors consult parents and partners in these cases.

Overweight among girls is a big problem. Dr. Cizkova has started special summer camps with strict

diet and plenty of exercise. But many of the girls relapse when they return home. And the doctors don't like to use appetite-cutting amphetamine drugs—widely used in the West and Japan as pep pills—because they fear addiction.

Communist countries have vast public health education programs, emphasizing preventive medicine. Sex education, while handled "very carefully", is well organized, with talks by doctors and group discussions. Boys and girls attend together. (Dr. Hubble thinks British youngsters should be segregated.)

While doctors generally favor more progressive sex education, the Swiss are plugging strongly for it. Here, where the abortion rate is the highest in the world, doctors feel that family, church and school must prepare girls for a responsible sex life based on love and not the need to be physically wanted. A leading doctor, Rose Hunziker, also points out that promiscuity causes chronic gynecologic problems that can last a lifetime.

In Egypt and the Middle East, the family is reportedly still the strongest institution and adolescent problems are more subtle than antisocial behavior. The traditional separation of the sexes is believed responsible for emotional repression, leading to earlier marriages and a higher birth rate, which hurts nations' economic development.

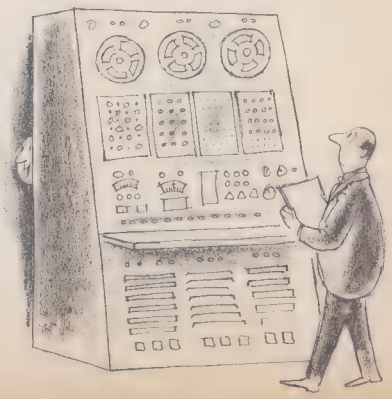
American doctors, who have focused on teen problems longer than any others — because our "advanced" technical civilization has helped to produce such problems earlier — emphasize the crucial importance of public opinion toward adolescents.

Dr. J. R. Gallagher of Harvard, chief of a big teen unit in a Boston hospital, was unanimously supported at the WHO conference when he said the world must recognize that adolescents' problems differ medically, socially, psychologically and economically from those of adults and children.

Adolescence is seen as a time of unique psychosocial stress, when the acceptance of other teens and of the community at large is crucial, especially in an increasingly complex modern society.

Doctors say parents and other authorities must strike a balance between protectiveness and permissiveness. Above all, they urge, we must show that we care. Only thus can we ultimately solve the problems of gangs, drinking, dropouts and apathy, and develop creative job opportunities. Teens may look quite mature, but they're not above caring.

"Good morning, Mr. Mann."



THE SPACE PICTURE

Man on the moon

NASA Photos

(Right) Interior view of metal mockup of Project Apollo's Lunar Excursion Module displayed recently by Grumman Aircraft.

(Below) Engineering test pilot Charles Smythe, wearing a Gemini-type pressure suit, stands before the full-scale LEM mockup.

(Above) Engineer Smythe demonstrates the accessibility of a scientific experiments package on the LEM. LEM is the portion of the Apollo spacecraft which will separate from the command module, in lunar orbit, and transport two astronauts to the surface of the moon, later returning them to the orbiting command module.

Behind engineer Smythe is an expanded S-band antenna for radio transmission back to the orbiting command module. The antenna can be unfolded like a giant mesh umbrella.

(Right) The LEM two-man cab is approximately 10 feet in diameter. It is mounted on four legs and stands 20 feet tall. The legs and descent stage will serve as a launch platform and will remain on lunar surface when LEM ascent stage rejoins orbiting spacecraft.

California's science "monopoly"

by Hubert Pryor

WHERE there's science, there's prosperity. Look at California.

Such is the theme of a study that promises to have a profound influence on the future of America.

The study was initiated in 1963 by then Senator Hubert H. Humphrey. Now, as Vice-President, Humphrey is working to get action so that the effects of the study will soon begin to be felt—perhaps later this year.

In one of his last acts as senator, Humphrey distributed a compendium of 826 pages of testimony, tables, charts and excerpts representing the views of the top scientific people in government, education and industry. They had testified before a Senate subcommittee, which Humphrey headed, between May 20 and December 18, 1963.

The consensus was that, beyond question, the United States is at a point where it absolutely must plan how its huge research efforts grow —and where.

To give force to the findings that the hearings brought out, Humphrey in September, 1964, introduced a joint Senate-House resolution to set up an agency known as the President's Advisory Staff on Scientific Information Management (PASSIM). Before the resolution could be acted on, the 88th Congress adjourned.

But Neal Peterson, Humphrey's counsel on the subcommittee, recently told *Science Digest* it's likely that another senator will reintroduce the resolution in the new Congress.

In any event, Peterson said, Humphrey will now make an effort to have the resolution made effective by executive order.

California is the star (some may say the villain) of the Humphrey study because of its unique position in making science—to put it bluntly—"pay."

That state, according to the latest figures, now gets $3,807,000,000 a year in government funds for research and development. That's more than four times as much as the second-best state, New York, and eight times as much as the third-best, Massachusetts.

The California figure, in fact, is more than one-third of the entire U.S. total.

California doesn't exactly have a monopoly on U.S. science, but to most of the rest of the country, it certainly seems as if it does.

Why?

Part of the answer was given to Humphrey's subcommittee by Dr. Roger Revelle, University Dean of Research at the University of California in Berkeley.

"California," he said, "is unique

in the world in that its educational institutions have, from the very beginning, emphasized the importance of science and technology.

"Furthermore, the entire educational system of the state—public and private—is a carefully planned and coordinated system: junior colleges, private and state colleges, the nine campuses of the University of California and three great private universities—Stanford, the University of Southern California and the California Institute of Technology."

From education has come science; from science, technology, and from technology, a huge array of new industries in such fields as aeronautics, electronics and space.

A typical instance cited before the Humphrey subcommittee was that of the area around Stanford University in Palo Alto.

In the 1930's, two engineering students at Stanford, William Hewlett and David Packard, spent much of their spare time in the attic laboratory of a young professor named Frederick T. Terman. They talked about forming their own electronics company some day and Terman encouraged them.

Later, as a graduate student, Hewlett, under Terman's guidance, began experimenting with an entirely new concept in radio engineering and built the first practical resistance-tuned oscillator. Packard joined Hewlett in his graduate studies and the two set up a partnership. Their assets: $538 in capital and the oscillator. Today, Hewlett-Packard is the world's largest manufacturer of electronic measuring instruments, with annual sales exceeding $100 million.

And according to *Industrial Research,* whose report on this and other similar cases was inserted in the subcommittee record, the San Francisco-Palo Alto scientific complex now numbers more than 200 electronics companies.

A similar scientific and technological explosion during the postwar years errupted in the Los Angeles area, with the result that today 29 percent of all people in the area who are employed in manufacturing are working for concerns that are defense or space connected.

The only comparable surge in science has occurred in the Boston-Cambridge area, in New York-New Jersey and Washington-Baltimore.

In the Boston-Cambridge area, the spark for the explosion came from Harvard and MIT. Early in World War II, the U.S. decided to locate four of its key research laboratories there because of their outstanding science and engineering departments. Among the new re-

David Packard, left, and William Hewlett started with only $538 and a good idea.

Humphrey doesn't want to "take away" from California, but seeks "new techniques" by which science will benefit all the United States.

search activities was the famous radiation laboratory, our major center for the development of radar, which once had a staff of 4,000.

The success of those ventures led to new government and private research ventures after the war, and today something like 400 companies in electronics and other technologies line Route 128, near Boston.

Do these facts mean that California and, to a lesser extent, Massachusetts have such a stranglehold on science in the U.S. that some of their bounty must be taken away from them and spread around?

The question was a sensitive one for Humphrey as senator from a state in a region that gets minimal amounts in government research and development contracts.

"Once you start getting these contracts," said Humphrey, "you tend to draw into that area where the R. & D. contract goes top grade personnel.

"In the meantime, you have these vast areas of the country where there is a feeling at least that there isn't adequate attention being given to research and development."

And Humphrey added:

"Now the response to this of the Department of Defense sometimes is, 'Well, the better people are on the West Coast or on the East Coast.' My response is, 'The reason they are there is because you put the contracts there that drew them there.' "

Humphrey insisted, however, that "I am not critical" of California or of the Boston area. And he added:

"These people have really gone out and produced, and they have shown initiative. I have implored our own people in the Midwest to show a little more initiative.

University vs. business

"There was always this aloofness. In other words, the university would be up here in the clear air and out of the smog of real life, and the business community would be down here saying, 'Well, let's have nothing to do with those professors.' "

Frustrated as he seemed to be, Humphrey did not advocate "taking away" from California and the other "haves" and giving to the scientific "havenots."

Dr. James R. Killian, Chairman of the Corporation of MIT, was a witness before the subcommittee when Humphrey expressed his quandary. He told Humphrey:

"I certainly feel that vigorous research programs in universities help generate the new technology, the new ideas, and the people that help to elevate and advance the economy, that this effect in general is national, but it can be regional in a very marked degree also.

"But I would also be very much concerned," Killian went on, "if we attempted through the support of basic research to try to make economic effects a primary objective. I think basic research, the pursuit of knowledge for its own sake, must be a fundamental, disinterested kind of activity. It has byproducts that are of very great importance, but if we attempt to try to make basic research an instrument of geographical advantage or an instrument of economic advance, we may hurt our national basic research program, hurt our national strength in doing so.

Geographical objectives

"I think this requirement for quality must be handled with great care and skill when considering geographical objectives."

In other words, science should not be a geographic football.

Answered Humphrey: "I think this differentiation is very important, and I would fully concur in what you have said."

In the resolution Humphrey offered last September, and in the speech that accompanied it, no mention was made of geography.

Nor is there any indication that geographical considerations will primarily motivate the advisory agency contemplated in the resolution that now may be set up by executive order.

The emphasis is on information, on having those in the Government who make decisions on research know the complex, far-reaching consequences.

Society's unsolved problems

As Humphrey told the Senate, we must "begin immediately to discover and apply new information management and decision-aiding techniques to the major unsolved problems of our society." He went on:

"Our economic growth must during this decade of 1960 and 1970 provide employment for 22 million workers whose jobs are expected to be replaced by automation and technology. At the same time another 12½ million new jobs must be created for young people entering the labor force for the first time. During the same period the exodus of workers from the agricultural sector will continue at the rate of 200,000 per year.

"Yet we do not fully understand the interrelating factors which bring about economic growth."

Humphrey, our new Vice-President, is known for his expressive, sometimes exaggerated speech. But those who see the signs of modern science felt he was laying it on the line when he added:

"If we cannot develop new techniques to master the new knowledge, to better perceive the ultimate nature of our changing institutions, and to assist our policy and decision makers, we may be turned down the dusty road to ruin, a road cluttered with the rubble of dimsighted decisions and poorly programed policies."

THE PSYCHOLOGY STORY

"Please send two free tickets"

HAS America lost its sense of humor? Robert F. Morgan, who is with the Psychology Department of Michigan State University, has reason to believe the answer is yes.

Morgan recently sent the following letter to 77 commercial airlines, railroads, steamship companies and other transportation concerns:

"Dear Sir: Please send two (2) free round-trip tickets to a point of your choosing. Thank you."

What he had in mind was a test of a rule of communication, which states that for people to communicate with each other, there must be two shared frames of reference. One is the type that permits the recipient of a message to attach the same *meanings* to it as the communicator. The second type presupposes that the recipient finds the communicator's meanings *relevant to himself*.

What was the reaction to Morgan's letter?

Well, two-thirds of the addressees didn't even answer it, which was no surprise to Morgan. But 24 companies did reply—six by air mail. The signatures included those of two district sales managers, three regional managers, one passenger service manager, one passenger traffic manager, one assistant to the

vice-president, one director of public relations and one vice-president.

The responses fell into the following categories:

1. *Reacting to the letter as if it did not contain the offending word "free."* The single letter in this category requested a deposit and two credit references.

2. *Irrelevant and inappropriate information.* Two respondents confessed not being able to supply the specific service requested.

3. *Interpreting the request to permit complying with it.* One airline company sent two cancelled tickets, with the explanation: "I assume these are for school use."

4. *Seriously replying to the unconventional request and offering information relevant to a more conventional inquiry.* Two airlines and a steamship company explained that they were unable to supply free transportation, but made counter-offers of commercial arrangements such as tourist flights and organized tours.

5. *Dealing with the inquiry as legitimate, and refusing the request.* Seven fell into this category.

6. *Demanding clarification.* A bus company regional manager wanted to know "what this has reference to so that satisfactory answer may be rendered you."

7. *Replying in a humorous fashion.* Only three fit this category. One airline enclosed two New York City subway tokens. Another chose Bogota, Colombia, as the destination and said it was expecting the fare. And a bus manufacturing concern "directed your letter to Santa Claus."

What are the sociological and psychological inferences?

Says Morgan, who is on a fellowship with the National Institute of Mental Health:

"Probably the most striking fact about the answers is their conventionality. They imply an attempt to 'conventionalize' the communication and deal with it accordingly.

"It is as if the managers of a zoo were presented with a dinosaur and relied on their experience with elephants and lizards.

Making sense

"Another fact that seems to emerge is the manifest desire of the correspondents to 'make sense' out of the problem presented. Several appeared to conclude that the framer of such an unusual query must be a child."

The conclusions?

"I have simply tried to argue that formal communications are generally confined to conformist molds," says Morgan.

"In the continuing human enterprise of 'making sense' out of impinging events by relying on past experience, routines—as John Dewey put it—'insist on their own continuation.'

"Only through intensive use of novelty can this cycle be broken. In other words, it is only when the improbable has become probable that most of us can cope with it in its own right."

PERSONALITY OF THE MONTH

The life of a theoretical scientist

by Edward J. Sozanski

ONE OF the nice things about being a theoretical chemist is that you can travel light. You don't need huge laboratories packed with expensive equipment, not even a test tube.

You can attack a problem, for example, while shaving, waiting for a bus, or eating lunch. You need only an office, a few reference books and a pad and pencil. But if you expect to be successful at this sort of business, it helps to be a genius.

Lars Onsager of Yale University is such a man. He has become one of the leading theorists in the world by applying his mind and his mathematical ability to developing new laws of physics and chemistry. In the process, he has earned the respect and admiration of scientists all over the globe.

One thing Onsager has not achieved is public recognition in the way that famous writers, artists, musicians are acclaimed. This is, perhaps, a kind of poetic injustice, because a scientist of Onsager's rank is just as creative as any artist.

His theory of irreversible thermodynamic processes, for example, may be more esoteric than "Swan Lake," but it is no less a creative work. Like a composer, Onsager works out the "tune" in his head, and when it sounds right, puts it down on paper.

Lars Onsager
"It helps to be a genius."

But like most scientists, he does not work for public recognition. His compelling urge lies in recognizing, attacking and solving the puzzles he uncovers in the physical universe. His mind becomes an extraordinary window, and as he peers through it into the world of atoms and molecules, periodic flashes of genius burst forth to illuminate shadows.

Lars Onsager has held the rank of J. Willard Gibbs Professor of Theoretical Chemistry at Yale since 1945. Gibbs—also a Yale man—was one of the giants of American science and advanced his greatest theories in the areas of physics,

chemistry and mathematics that are Onsager's domain.

Gibbs was not widely acclaimed until long after his death in 1903. But Professor Onsager is already a "name" among scientists if not to the general public, and has received many distinguished scientific honors. The first, in 1953, was the Rumford Medal of the American Academy of Arts and Sciences. The other two recipients that year were Enrico Fermi, the 1938 Nobel laureate in physics, and Willis E. Lamb Jr., who shared the 1955 Nobel physics prize.

The Royal Netherlands Academy of Sciences honored Onsager in 1958 by naming him to receive the Lorentz Medal, which, at the time, had been awarded only six times since it was established in 1927. In 1962, he received not one, but three American Chemical Society medals.

Now, the A.C.S. has named him to receive its Peter Debye Award in Physical Chemistry at the Society's annual meeting this spring. The $2,000 prize honors the Nobel laureate under whom Onsager studied in Zurich.

Onsager came to Yale in 1933 to study as a Sterling Fellow. He was appointed to the faculty in 1934.

A tall, balding, heavy-set man with rugged Nordic features that confirm his Norwegian ancestry, Onsager speaks softly, with just a trace of an accent, but rarely about himself. An unassuming person, he volunteers only basic biographical details when asked. Interviewers are often frustrated in their attempts to extract a delicately shaded portrait in words of the "complete man," and may come away thinking Onsager is cold and aloof.

His friends, colleagues and students know that he is anything but a stereotype of the "ivory-tower" scientist. As they have recognized his remarkable mathematical ability, they also marvel at his range of knowledge, his wry, pentrating sense of humor and his lucid writing style.

How has Lars Onsager established himself, in the words of his 1954 honorary degree citation from Harvard, as "a worthy successor to Willard Gibbs, who through theory explains reality?"

Like Gibbs, Onsager has made his most significant contributions in the area of thermodynamics and statistical mechanics. In two papers published early in his career, he examined cross coefficients in linear equations that describe the various fluxes in simultaneous irreversible processes like heat conduction, electrical conduction and diffusion. The cross coefficients, he demonstrated, are simply and predictably related to each other.

His other contributions include his classic work on the transport properties of electrolytes, compounds that conduct electricity in liquids; also, the theory of diffusion, dielectric properties of liquids and the theory of the structure and electrical properties of ice.

In the field of electrolytes, his theories explaining the movement of electrolytes in solutions—as related to factors such as fluid density and turbulences—are credited with

Onsager's knowledge extends to all areas of science. He is said to know all the plants on his New Hampshire farm by their Latin names.

having a profound effect on the development of physical chemistry.

The reasons for Onsager's achievements are easier to understand than the problems he studies. These insights come from his friends and colleagues at Yale's Sterling Chemistry Laboratory, where Onsager occupies an unpretentious office at the end of a second-floor corridor.

First, they say, Onsager was blessed with high native intelligence, and he learned the fundamental kinds of mathematics early in life at good schools. He was born in Oslo on Nov. 27, 1903. His father, Erling Onsager, was a lawyer, and his mother occasionally taught school as a substitute teacher.

Young Lars was graduated from the Norwegian Technical Institute at Trondheim in 1925 with a chemical engineering degree. He studied at the Swiss Federal Institute of Technology at Zurich from 1926-28, when he came to the United States to take a job as an Associate in Chemistry at Johns Hopkins University.

While he was at Johns Hopkins, he delivered a paper at an American Chemical Society meeting. Charles A. Kraus, the distinguished physical chemist from Brown University, was so impressed by young Onsager's reasoning and persuasiveness that he brought him to Providence in 1928 as a research Instructor in Chemistry. Onsager remained at Brown until coming to Yale in 1933.

The abilities that he sharpened during those years of study were these—the insight to perceive what forms physical problems can be put into, and how they can be solved mathematically; a rare skill at applying his mathematical ability to these problems and intense powers of concentration.

"Perhaps what he is best at," according to Professor Andrew Patterson Jr., a colleague, "is making subtle mathematical substitutions which will collapse a formidable problem into a solvable one. This is real insight. In a time before computers became popular, he was able to make mathematical approximations which allowed problems to be solved that couldn't have been solved in any other way."

Professor Raymond Fuoss, another colleague who has known Onsager since they studied together under Kraus and who has collaborated with him in writing many scientific papers, calls him a mathematical genius "who can do mental mathematical analysis the way we do simple arithmetic."

The sight of Onsager prowling the corridors of Sterling Laboratory puffing on his pipe, sometimes thinking out loud, means he has a mathematical problem on his mind, and

wants to talk it over with someone.

"Sometimes he'll drop into your office with a smile on his face," Prof. Patterson says. "That means he wants to discuss his problem."

The joy, for him, is in solving the problems, not in publishing the results, much to the dismay of fellow scientists.

"He will carry a problem through until he sees the solution, then put it aside," Prof. Fuoss says. "He has many things on his desk that could be published if he would clean them up."

Onsager speaks Norwegian, German and French fluently, besides English, and "gets along" in Italian, Swedish and Danish. Far from being confined to chemistry and physics, his knowledge extends to all areas of science, especially botany, and to the arts. He is said to know all the plants on his New Hampshire farm by their Latin names.

Onsager and his wife, the former Margarethe Arledter, were married in Cologne, Germany, on Sept. 7, 1933. They have four children—Erling Frederick, Inger Marie, Hans Tanberg and Christian Carl, and five grandchildren. Onsager says only the youngest, Christian, has shown any inclination toward a scientific career.

Now in his 61st year, the dean of Yale chemists has compiled an enviable record—a substantial body of work, the acclaim of his professional colleagues and a shelf full of medals and honors—all this with just a pad, a pencil and a window on the universe.

How Fast Can You Read?

A noted publisher in Chicago reports there is a simple technique of rapid reading which should enable you to double your reading speed by this simple, proven method and yet retain much more. Most people do not realize how much they could increase their pleasure, success and income through reading faster, easier, more accurately. The details of this method are described in a new book, "Adventures in Reading Improvement" sent free on request.

According to this publisher, anyone, regardless of his present reading habits and reading speed, can use this simple technique to improve his reading ability and develop it to a remarkable degree. Whether reading stories, textbooks, technical matter, it becomes possible to read sentences at a glance and entire pages in seconds by following this method.

To acquaint the readers of this publication with the easy-to-follow rules for developing rapid reading skill, the company has printed full details of their interesting self-training method in a new book, "Adventures in Reading Improvement" which will be mailed free to anyone who requests it. No obligation.

Simply send your request to: Reading Improvement Program, 835 Diversey Parkway, Dept. C782, Chicago, Illinois 60614. A postcard will do.

THE PROGRESS OF MEDICINE

How good are flu vaccines?

by Arthur J. Snider

Both in 1918 and 1957, serious epidemics of influenza spread throughout the United States. The evidence in both outbreaks suggested that pregnant women were more vulnerable to the disease than the non-pregnant.

When a recurrence of Asian influenza was anticipated during the winter of 1962-3, the U.S. Public Health Service recommended that pregnant women be given priority over the general population in the administration of vaccine.

A pilot study was carried out at the Magee-Womens Hospital in Pittsburgh. Obstetrical patients were offered participation in the flu vaccine program. Evaluating the results now, Dr. Jaroslav F. Hulkahas of the University of Pittsburgh said they established the comforting fact that pregnant women are able to respond to this type of immunization similarly to the non-pregnant. Age of the patient and stage of gestation had no negative effect. Also comforting was the lack of fetal damage, as expressed in miscarriage or birth deformities.

But the beneficial effects of the immunization appeared to Dr. Hulkahas to be debatable. While the vaccine reduced the number of patients who became ill with upper respiratory diseases during the winter from about 23 percent to 15 percent, the difference was not found to be statistically significant.

Analyzing the data another way, non-immunized patients ran a risk of about one day in bed due to influenza-like symptoms whereas immunized risked .38 days. To their risks, however, must be added risks attending immunization. Since immunized patients run a risk of .40 days in bed due to weakness, they run a risk of .48 plus .38 or .78 days in bed compared to an average risk of one day in bed for the non-immunized patient. These risks are not very different.

How to stop smoking without really quitting

In the year since the Federal indictment of cigarettes as a contributor to lung cancer and heart disease, a past president of the American Heart Association finds cigarrette smokers have shaken down into patterns.

The first type is the "compromiser," finds Dr. Howard B. Sprague of Boston. The compromiser quit—almost. He just took a cigarette after a cup of coffee. But within a few weeks he was chiseling and now is back where he started.

The "fibber" comprises another group. He promised to cut down from his three packs a day. He proudly declared on his visit to the doctor that he had succeeded in reducing to two packs. But it turned out that two packs was what he was smoking all along.

Another type is the "knower." He is the educated layman who keeps well informed on medical science. He remains unconvinced that the relationship between smoking and heart disease is anything but coincidental. Cancer and emphysema do not worry him because his father and his father's father smoked and it wasn't these diseases that ultimately did them in, the "knower" tells Dr. Sprague.

The "filter man" is an offshoot of the "knower." He has discovered to his delight that science doesn't know enough about filter cigarettes for anyone to make a conclusive statement. Absence of statistics is assurance enough for him. (Dr. Sprague says the evidence now available indicates that the average filter removes about a third of the nicotine from cigarette smoke).

The "you-can't-do-this-to-me" type insists he cannot live without cigarettes. Giving up smoking would kill him just as certainly as not giving it up. There is nothing you can do about him, says Dr. Sprague.

Electronic pacemaker for kidney

In one type of kidney disease, the ureter tube loses its ability to contract properly, thus allowing urinary backflow from the bladder to the kidney. This abnormal condition is damaging to the kidney if allowed to persist.

For the first time, an electronic pacemaker has been applied to a problem of this kind. In a 6-year-old girl whose ureter was damaged, the pacemaker was inserted for three months. Electrodes were connected to the ureter just below the child's kidney to reestablish ureteral contractions by electrical stimulation every 10 to 15 seconds. When ureter contractions returned to normal, the pacemaker was removed. Commenting on the case, Dr. William F. Melick of St. Louis University said:

"Naturally, the success in a single case does not constitute a panacea for children suffering from kidney disease."

Experimental spot treatment

The day may come when physicians will be able to guide tiny vehicles around within the body to move drugs, doses of radiation or even microsurgical instruments to trouble spots.

At Tulane University, a group of scientists have succeeded in controlling the movement of small iron particles within the bodies of experimental animals. This was accomplished by using magnets to pull the metallic bits in the natural pathways of the blood circulation system, the lymph channels and the gastrointestinal tract.

Dr. Phillip H. Meyers injects the particles into solution—in animals, so far—and the magnets move them from place to place within the body or hold them at a particular site for as long as is needed.

Theoretically, the vehicles could carry drugs for release at specific spots within the body or could carry a catheter to withdraw the blood of a clot, or could carry radiation for x-ray therapy at a certain spot within the body.

What blood can tell

On a third floor wing of the Yale School of Medicine is one of the most unusual reference "banks" in the world. It consists of 20,000 blood samples from all over the world. Dr. John R. Paul, noted for his work in virology, particularly polio research, uses the samples as a method of gathering health information from areas of the world where vital statistics and health records are either sketchy or nonexistent.

A surprising amount of information may be found in a tiny blood sample. Through analysis, Dr. Paul can measure the state of immunity to a specific disease and the level of blood chemicals, such as cholesterol. He may even find infections so minor they were scarcely noticed. Former infections are determined by the presence of antibodies, the defense mechanisms against infection.

About 15 drops of blood are taken from several hundred or even thousands of normal individuals in a given population. The quantity is enough to obtain about 50 items of information from each individual. Individually, the measurements are often inconclusive but taken together they can give the investigator a picture of the health situation within a given community or population, even broken down for age, geography and socio-economic status.

In a survey conducted among Eskimos in northern Alaska seeking Type I poliovirus in 1949, Dr. Paul was able to learn that they were

vulnerable to epidemics. Additionally, he learned that the antibodies formed by exposure to the polio virus were long-lived, a discovery that was a milestone in the development of polio vaccine.

By studying blood samples from Puerto Ricans living in San Juan and comparing them with a group living in New York, Dr. Paul was able to study the effects of migration from a rural to an urban environment and from a semi-tropical to a temperate climate.

The samples provide a permanent reference library since they can be stored indefinitely in frozen or dried form without deterioration. They can be farmed out to scientists in many parts of the country who have taken an interest in a particular disease.

The facility is sponsored by the World Health Organization, and is one of three in the world, and the only one in the Western Hemisphere.

Eating laundry starch widespread

Add to the bizarre cravings of pregnant women: laundry starch.

A study at Cook County Hospital in Chicago showed more than a third of 1,000 admitted eating laundry starch throughout pregnancy.

Dr. Louis Keith, who conducted the survey, said there is a misguided belief that the starch will induce an easy labor. Actually, it produced an adverse effect. Many of the women suffered a severe iron deficiency anemia.

Too few females

A possible female shortage looms in the biological future of man, says a statistical researcher. The reason is the increasing preservation of the newborn.

About 106 boys are born for every 100 girls. Until now, the increasing rate of mortality for males during infancy and childhood has reduced the ratio to 100 men for every 100 women. The male drop-off through death accelerates as men grow older, until there are many widows.

Should medicine figure out a way to further reduce prenatal mortality, as Dr. Sheldon Berger of Evanston (Ill.) Hospital believes it will, a ratio of 50 percent more boys than girls will be seen at birth. Were this situation to persist to the age of marriage, there would be a world shortage of marriageable females. Women would assume greater scarcity value and certain significant social consequences would have to be considered.

End of world scourge

by Ora Mendels

THERE are ten million blind people in the world. Blindness for the large majority has been caused by the highly contagious disease, trachoma. A major breakthrough in centuries' old attempts to control the disease has come from South Africa, where a team of scientists has developed a vaccine that shows promise of wiping out the disease that today affects one quarter of the world's population.

Trachoma is as old as man. Early Chinese writings record it; ancient Greece and Rome were ravaged by it. It leaves a trail of fear and poverty, of widespread human agony, of tremendous industrial losses. It is the cause of 80 percent of all blindness in the world.

Trachoma is a form of chronic conjunctivitis, which flourishes in crowded unhygienic surroundings. It is a menace in impoverished Africa (20 out of every 1,000 are blind) and Asia; the U.S., too, had its trachoma "belt," (including parts of Virginia, Kentucky, Missouri, Arkansas and Oklahoma) but this has been largely controlled.

Following the development of vaccines for the viruses that cause polio, measles and 'flu, the preparation of a one-shot vaccine for trachoma was clearly the ideal solution for a widespread human tragedy.

It has been possible to treat the disease only for the last 25 years. Its prevention has been impossible. Now, from South Africa, has come a vaccine, currently undergoing clinical trials, that may be one of the major medical breakthroughs.

Until very recently, the cause of trachoma was inexplicable, its cure impossible, its prevention a scientist's dream as bold as the unlikely vision, two decades ago, of a means of controlling poliomylitis. Reports now available show that the incidence of trachoma has been reduced from 35 percent to 5 percent in a group of 60,000 African school children, since the trial was initiated five years ago.

The South African trachoma project is headed by Dr. James H. S. Gear, present Director of the South African Institute of Medical Research and known for contributions to viral research, and for his personal achievement in virtually destroying polio in South Africa. His investigations could have earned him distinguished post-graduate degrees many times over.

The promise of the vaccine is universal, for trachoma is an international as well as a human problem. Blindness costs the world billions of dollars every year, because of unemployment, and the need for pensions, rehabilitation and social work.

REPORT OF THE MONTH

Is there a fifth force in the universe?

Photo Cern

Scientist at CERN, the European Center for Nuclear Research near Geneva, prepares equipment for part of the experiment which may determine the existence of a fifth force.

by Bruce H. Frisch

A NEW force in the universe may have revealed itself by threatening two of physics' most precious rules. In an experiment last year, the world's most powerful atom-smasher seemed to pulverize the two laws. Scientists are now trying to put them together again by using the same atom-smasher to detect a possible interloper in the first experiment—a previously unknown force.

There are four known forces in the universe; the new one would be the fifth force. Gravity is the weakest known force, and was the first to be recognized. Newton fairly well defined gravity 300 years ago. It takes a body the size of the earth to make a pint of water weigh a pound.

The electromagnetic force is the other one that influences the man-size world. Ben Franklin first recognized its true nature, and most of its actions had been explained by the end of the nineteenth century. All of its manifestations arise from positive and negative electric charges. An imbalance of charge makes plastic bags stick together or stands your hair on end. When the imbalance becomes too great between the earth and a cloud, lightning strikes. Charges in motion create a magnetic field. Radio, radiant heat, light and x-rays are electromagnetic. In an atom the electromagnetic attraction between positively charged protons in the nucleus and negatively charged electrons keeps the electrons locked in orbit.

Yet, in the nucleus, protons that

There is nothing special about one direction in time. Mathematically, an antiparticle can be called a particle going backward in time.

repel each other exist close together. This is because the electromagnetic force is overcome by the most powerful known force, the nuclear binding force. It has been unleashed in the atomic bomb. In the laboratory physicists can tell the force is at work in a nuclear reaction if the reaction occurs very quickly.

Other nuclear reactions occur very slowly in comparison. Scientists reason that they are caused by a weaker force acting over a long time—a ten-billionth of a second or more. This force is called simply the force of weak interactions, and accounts for radioactive decay, the spontaneous breaking apart of atoms or the particles that make up atoms. It is a troublemaker. It doesn't seem to follow the rules.

Nuclear physics is partly a matter of bookkeeping. Some of the bookkeeping rules are conservation laws, such as the conservation of energy. The sum of the energy before the reaction must equal the sum of the energy after the reaction.

Another rule is the conservation of parity. Parity is the mathematical expression of the principle that the mirror image of a physical process shows a process that is possible. Switching left and right does not change physical laws, according to this principle.

There is positive parity and negative parity. The sums of parity before the reaction and after the reaction must always be the same. Or almost always. There was one particle called the K zero meson (K^0) (zero because it has no electric charge, and meson because it is a middleweight among particles) that seemed to decay into particles with both kinds of parity. In this one way it acted as if it were two particles, K^0_1 and K^0_2. In all other ways it acted as if it were one. In order to save the law of conservation of parity it would have been convenient to call K^0 two particles. But in 1956 two young physicists, Chen Yang and Tsung Lee, working at Brookhaven National Laboratory, Upton, Long Island, decided facts were facts. Parity probably didn't hold for weak interactions. K^0 was only one particle.

They suggested an experiment to prove their point.

Mrs. Chien-Shung Wu of Columbia U. and a group of low temperature specialists from the National Bureau of Standards carried out the Lee and Yang experiment. They watched the decay of cobalt-60 and found that the mirror image of the decay is of a reaction that never takes place, so is considered impossible. Parity had fallen.

Physicists quickly caught their balance. If every particle in the mirror image is replaced by its antiparticle, it once again shows a picture

of a possible reaction, they noted. Charge conjugation is the name for the act of switching matter and anti-matter in a reaction. Parity (P) alone may not be invariant, but parity and charge conjugation (C) together (CP) are invariant, they figured. In fact, physicists refurbished the old mirror image completely, saying that perhaps they just hadn't recognized what they had seen in a mirror, that the image may have consisted of anti-matter all along.

An anti-particle is like its corresponding particle except that it has the opposite charge or the reverse spin if the particle has charge or spin. A particle and anti-particle can be created as a pair from energy, and if they meet they annihilate each other and return to energy. One way of describing an anti-particle mathematically, is as a particle going backwards in time. We are made of matter so we go forward in time. This sounds peculiar, but in relativity there is nothing special about any one direction in time. According to the principle of time reversal invariance (T), one can take a movie of any event, run it backwards and watch perfectly possible happenings. They don't have to be probable. Time reversal invariance means physical laws will remain unchanged if the direction of time is reversed.

Physicists had CP invariance and T invariance separately, and they joined them together into CPT invariance. Supposedly, physical laws would be unchanged in a mirror image of an event in which all particles were replaced by their anti-particles and time was reversed.

Overall view of the linear accelerator (linac) tank and auxiliary equipment at Brookhaven National Laboratory, where the U.S. phase of the test is being conducted.

That was how things stood when a Princeton U. team under Val Fitch examined the decay of K^0_2 at Brookhaven last year. The combination of a weak interaction and the K^0_2 again made trouble. Fitch was watching for the breakup of K^0_2 into two pi mesons. It had never been seen before, but only a few hundred decays had been checked. Two pi decay would violate CP invariance and send it down the drain. Fitch wanted to put a firmer foundation under CP invariance, so he checked 22,700 decays. Unfortunately, he found 45 two pi decays. CP was lost, and with it either CPT or T. Physicists had a choice. If they would admit a violation of time reversal invari-

ance, they could make CPT add up right. If they would abandon CPT invariance, they could save T. They firmly believed in CPT, and time reversal invariance was vital to relativity. They took neither alternative. Instead, they called on a new force to save the day.

This fifth force, if it exists, is the weakest one, ten billion times weaker than gravity. It may have taken the fifth force of the whole galaxy to influence the experiment. The reason for its action would be because our part of the universe has so much more matter than antimatter. It may have changed some K^0_2 into K^0_1 which ordinarily decay into two pi mesons.

The effect of the fifth force would increase by the square of the particle energy. With about the same setup Fitch collected data at higher energies in Sept. of last year and during Dec. and Jan. CERN, the European Center for Nuclear Research near Geneva, has an alternating gradient synchrotron almost as powerful as the one at Brookhaven. R. Mermod collected evidence with it in early December.

Both teams are also checking for possible sources of error in the original experiment that would explain the results, but they don't really expect to find any.

Whatever the results show, it won't be the end of the story. In an indisputable understatement, B. Gregory, CERN Director of Research says, "One experiment never gives final proof."

Aerial view shows building (foreground) housing Brookhaven's 80-inch liquid hydrogen bubble chamber. Behind building is the alternating gradient synchrotron, with its one-half-mile-circumference magnet ring buried under 12 feet of earth.

The human side of industry

by Flora Rheta Schreiber and Melvin Herman

TOPEKA, Kansas, is preparing for an influx of high-ranking industrial executives from every state in the Union. Why? Because both industry and psychiatry are becoming more and more interested in examining the human side of work. In Topeka, the business leaders will attend seminars for executives held by the Division of Industrial Mental Health of the famous Menninger Foundation.

A new force has been entering industry—the human relations movement. According to Dr. Harry Levinson, the psychologist who serves as Director of the Industrial Division, top management has shifted from a concern only with profit today to the long-term survival of the organization. This means that companies must have employees who are loyal, who will stay and who are psychologically equipped to contribute to the limit of their creativity.

The relationship between a man and the organization for which he works is now recognized as having great significance to the individual

and the group. People fill various conscious and unconscious psychological needs through their work. They project human qualities even into a mammoth industrial organization and then relate to the firm as if it did in fact have these human qualities. Dr. Levinson says that "what the psychoanalyst calls transference occurs with respect to organizations and institutions, just as it does with individuals." His definition of transference is "unconsciously bringing past attitudes, impulses, wishes and expectations, particularly those usually experienced toward parents, into present situations, usually in exaggerated form." Years ago people built up closer family relationships, even town and neighborhood ties that were very strong. Today, much of this is felt toward the organization for which people work. There is another element. When people develop closeness to each other over a period of time, conditions are created in which reality tends to get lost.

There is a psychological contract between the individual and the organization. Successful adherence to the contract results in mentally healthy people. However, when the agreement breaks down, symptoms of mental ill-health appear. A man's work situation directly contributes to his well-being or precipitates his illness. There is accumulating evidence that links the onset of physical illness to an individual's particular job. Men in personal service, for instance, have a higher incidence of hypertension than those who earn their living in other fields. White collar workers lead in acute gastrointestinal and circulatory conditions. First level supervisors have more ulcers than other occupational groups. Coronary disease seems to be directly related to excessive responsibility for the control and direction of one's own behavior. In Britain, coronary thrombosis is higher among bus drivers than among bus conductors. Significantly, too, *The Wall Street Journal* of June 5, 1962, reported that courts are ruling that employers are responsible for employees' heart attacks.

Social responsibility

There is a growing sense of social responsibility, Dr. Levinson reports, on the part of the corporation. It came about because of the realization that it was to the companies' self-interest to care. Men working no longer meant productivity alone. What mattered, too, was what was going on within the man himself.

Many studies have been undertaken to investigate men at work. The studies were concerned with individual and group interrelationships as expressed in such elements as status, leadership, group cohesion, motivation, productivity, turnover and even morals.

Miss Schreiber is an award-winning writer on psychiatry; Herman, the Executive Secretary of the National Association of Private Psychiatric Hospitals.

The type of illness a person gets may be linked to the job he has. Heart disease seems related to jobs with excessive responsibility.

For quite some time, however, these studies had little effect on the occupational physician. While he could understand their general importance, he felt that little of the information related to the problems that confronted him. One of his handicaps is that most of the health problems he sees originate outside the plant. Statistics from General Motors indicate that over 86 percent of all sickness absenteeism is due to non-occupational illness. And in the area of mental health, the physician never had the time necessary even to give counsel to all the employees who might have emotional difficulties. Beyond that, the suggested steps were rarely within the skill of the physician.

Occupational medicine

Today, Dr. Levinson says, occupational medicine has grown, from being the domain, "of a small in-group that fed on its own self-praise, to a medical specialty with its own body of knowledge and responsible participation in both the councils of medicine and management.

"Occupational medicine stands at the threshold of a new surge in its development," Dr. Levinson continues. He believes that three major trends are converging, which will bring about a metamorphosis in the field. He lists these trends as:

1) The change in science as a whole.
2) The historical development of medicine.
3) The growing importance of the industrial organization to the people who work in it.

The field of occupational medicine—again according to Dr. Levinson—will follow the same evolutionary pattern taken by medicine as a whole. This pattern moves from diagnosis to therapy to prevention. Essentially, occupational medicine has been preventive in nature. Yet efforts to date have been only a tuning up for a performance of greater magnitude. Present portents indicate that occupational medicine is now on the threshold of its major preventive phase.

The industrial physician must know not only psychosomatic medicine but also psychosocial medicine. Occupational health will be more and more a central concern of management.

Alan A. McLean, M.D., an outstanding leader in Industrial Psychiatry, predicted that in the future the "behavioral sciences will assist management in maintaining policies designed to promote a more carefully balanced relationship between the employee and his organization."

The many faces of schizophrenia

Research in schizophrenia is in a ferment, as indicated by a report just issued by the National Institute of Mental Health. This federal agency has backed 1,849 projects, in this field since 1948.

"There are no assurances on the basis of current research," the Institute reports, "that the schizophrenic illnesses which have challenged the best scientific minds for 2,000 years will be solved within the next year or two." At the same time, there are striking new insights that emerge from the research.

Symptoms of schizophrenia, it now seems clear, are varied, not fixed. What one group of psychiatrists describes as schizophrenia, another group, equally knowledgeable, does not. Nor is there one accepted approach to the treatment of schizophrenia. Schizophrenia, for the most part, remains the great unsolved psychiatric problem.

On one point alone, most investigators agree—schizophrenia is not a disease, but a pattern of behavior that is sick.

Discernible, too, is progress in the day-to-day care of a schizophrenic. Ten years ago, for instance, a schizophrenic was very likely to be hospitalized for most of his life. Today, however, he has a good chance outside a hospital. Virtually every psychiatrist with whom we discussed the question, has on maintenance care chronic schizophrenics who live rewarding lives. (See *Inside Psychiatry Today*, June, 1964, issue of *Science Digest.*)

Progress is also being made on the research level. Schizophrenia, uncharted and undefined, is being studied not by one discipline, but by many. New instruments are being developed. For example, in measuring the process involved in the registration of sensory information in the brain and to some extent the transition into motor activity, instruments are currently being used that are easier and more reliable than the customary electroencephalograms.

Experiments point to the as yet unconfirmed possibility that abnormal protein produces certain behavior, metabolic or cellular changes. Witness to this possibility is that the injection of a portion of protein from a schizophrenic's body into a non-schizophrenic volunteer induced in the non-schizophrenic psychiatric symptoms that could be described as schizophrenic. Other psychosis-inducing experiments are under way—antibody, enzyme and serum experiments.

Injections of a portion of protein from a schizophrenic's body into the body of a normal person can induce psychotic symptoms.

Biological research, without promising an imminent breakthrough, has introduced many new techniques and concepts. There are, for instance, statistical studies of the incidence of schizophrenia in families and in twins.

Many investigators agree that childhood experiences, patterns of family interaction and cultural attitudes, produce the behavior found in schizophrenics. Some investigators believe that these factors are more likely to trigger schizophrenic behavior when the genetic and biochemical abnormalities as well as neurological factors, also are present. Studies of adult monkeys kept in complete isolation during infancy reveal abnormalities comparable to those found in human schizophrenics whose histories show isolated, deprived childhoods.

Family interaction is emerging as a more and more important source of schizophrenia. The emphasis is being placed on the family unit—the interaction among father, mother and children—as the primary teacher of social interaction and thus as the basic incubator of schizophrenia. Histories of schizophrenic patients reveal that father as well as mother, establish the climate for the child's emotional development. These histories show, too, that the relationship between the parents themselves is vital in producing either a healthy or a schizophrenic environment. The child's order of birth also is being studied. Hospital patients show that there are more schizophrenics among younger than among older brothers and sisters in families of five or more children.

Economic status is another important factor. A New Haven project, for instance, indicated that the incidence of schizophrenia is higher in lower economic classes. A study in the Manhattan area, resulting in a book entitled *Mental Health in the Metropolis,* sheds light on the relationship between socio-economic levels and availability of treatment.

Strong family ties, however, can counteract the stress of economic deprivation and also of social isolation, as shown by a study of various Italian-American groups.

The quest for drugs effective in the treatment of schizophrenics continues. Some of these drugs have helped to return patients to their communities, by reducing the chance of relapse and rehospitalization. There also are new insights with regard to drugs—that, for instance, a child's response is often quite different from an adult's and there are great individual differences even among adults. For this reason specific drugs are suited to specific schizophrenic types.

Much research now focuses on how to prevent schizophrenia. The particular concentration of these prevention studies is on high-risk groups so as to help to identify those persons who are schizophrenia-prone. On the strength of an initial interview with a child's parents, investigators have been able to predict the degree of the child's schizophrenic psychopathology.

TIPS AND TRENDS

UNDERGROUND NUCLEAR BLASTS. They can be detected, it's now felt. The nuclear test ban treaty of 1963 excepted underground tests because it was thought detection was undependable. Recently, the U.S. revealed that it has been recording Soviet underground blasts for some time. And our underground nuclear test in Mississippi in October was picked up in Finland and Sweden. In the meantime, a Presidential task force has been working to stem the spread of nuclear arms. In view: a nonproliferation treaty to be signed by the nations of the world.

"TAKE HER UP." When the skipper of a U.S. Navy submarine gives that command some time in the future, he may not mean that the sub should rise just to the surface but that it should keep going into the air. The possibility arises with the award of a $36,000 Navy contract to Convair and Electric Boat for analytical and design studies of a sub that can fly. One Navy expert says a small craft weighing 6 tons or a little more might be able to make 10 knots upto 75 feet under water and fly at upto 225 knots.

REVOLUTION IN STEELMAKING. That's the promise of what U.S. Steel calls "one of the major technological advances" in the history of the industry. It's a process for coating light-gauge flat-rolled steel with other metals, including aluminum. Of interest in can-making and packaging, the process involves vaporizing the aluminum or other metal before depositing it.

WANT TO BE 10 TIMES STRONGER? It's possible, without exercise. Scientists in the aeronautical lab of Cornell U. in New York are developing a metal exo-skeleton for the Office of Naval Research that multiplies muscular strength so that a man can uproot a small tree or bear huge loads.

COLDS AND FOOD POISONING. Those are the two major ailments, according to some authorities. And a committee set up by the National Academy of Sciences says the dangers of food poisoning may be rising because of modern food industry techniques. Suspect and most urgently requiring regulation: frozen or dried eggs, yeast, coconut; precooked frozen foods of a moist, neutral nature; precooked chilled foods.

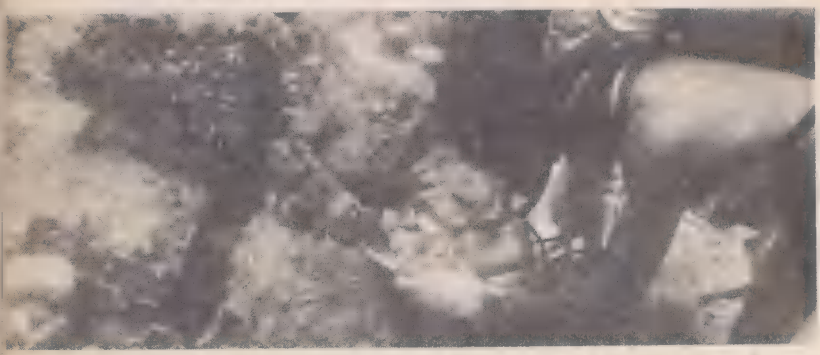
SATELLITE FOR EVERYBODY. You could make personal use of a satellite this spring. That's when Comsat (Communications Satellite Corporation) will start using a satellite known as Early Bird to be put into orbit 22,300 miles over the Atlantic. But if you use it to call a friend in London, say, you may notice something odd: an 0.6 second delay between the time you finish a statement and the other party responds. The speed of light is just so fast.

NEW USES FOR DMSO. Chemists call it dimethyl sulfoxide. Doctors call it astonishing. It's the drug that can relieve pain and inflammation, immobilize germs and even act as a tranquilizer. Its co-discoverer, U. of Oregon's Dr. Stanley W. Jacob, says 3,000 doctors and scientists are now testing DMSO uses. Big new bet: burns.

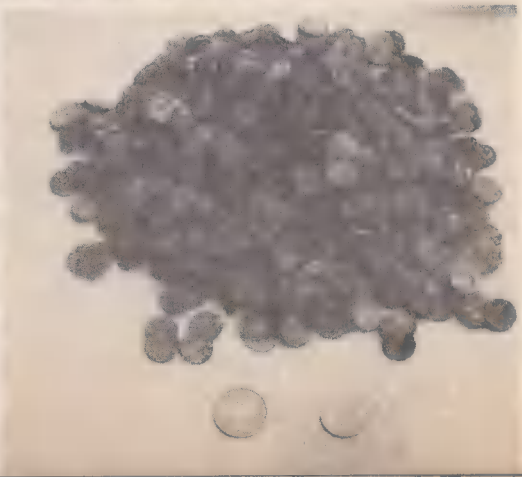
Underwater archaeology

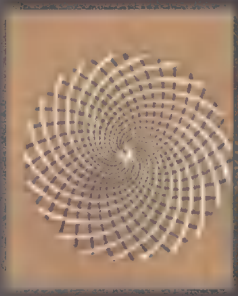
THE underwater archaeologist is interested in more than treasure. These photos and the story on pages 54 and 55 describe an expedition in the waters off Ceylon.

One of the major achievements in Ceylon was discovery of the ruins of the sunken Konesar Temple, which was located along with the wrecked treasure ship.



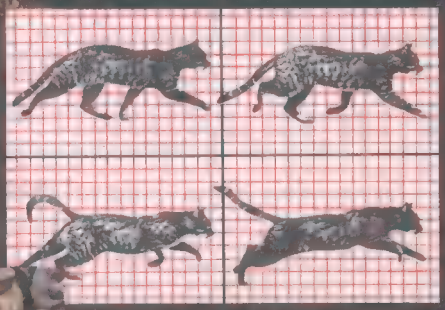
Sand and coral growth had formed much of the material from the Great Basses wreck into a solid mass which had to be chipped out in lumps to be brought to the surface. Every lump contained a mass of rupees and half rupees.





FROM THE MYSTERIOUS GEOMETRY OF NATURE . . .

The double spiraling of the daisy head bears a curious relationship with a mathematical sequence known as the Fibonacci series. It is produced by starting with 1 and adding the last two numbers to arrive at the next: 1, 1, 2, 3, 5, 8, 13, 21, 34, etc. The daisy head has 21 clockwise spirals, 34 counter-clockwise!



. . . TO THE CALCULUS IN A STARTLED CAT . . .

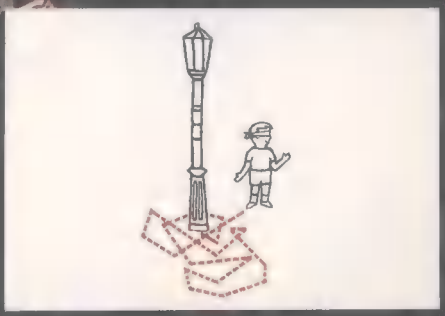
Just as a movie film consists of repeated still pictures of a moving object, so does Calculus break motion down into an infinite number of "instants." Thus mathematicians can calculate an object's speed and acceleration at a specific instant.

. . . TO THE AMAZING COINCIDENCE OF BIRTHDAYS . . .

Out of any 30 people in a crowd, the odds are better than two to one that at least two of them have birthdays on the same date. Above 50 people, the chance approaches certainty. Try it on 50 friends!

. . . TO THE "RANDOM WALK" PRINCIPLE OF MODERN PHYSICS

If a blindfolded boy walks away from a lamppost, changing direction now and then according to whim, the "law of disorder" predicts that he will keep returning to the lamppost. Young Einstein used this principle to describe the movement of tiny particles suspended in a liquid.



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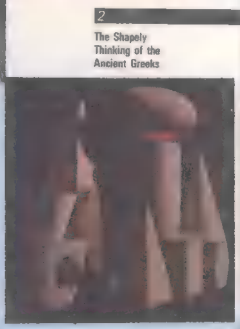

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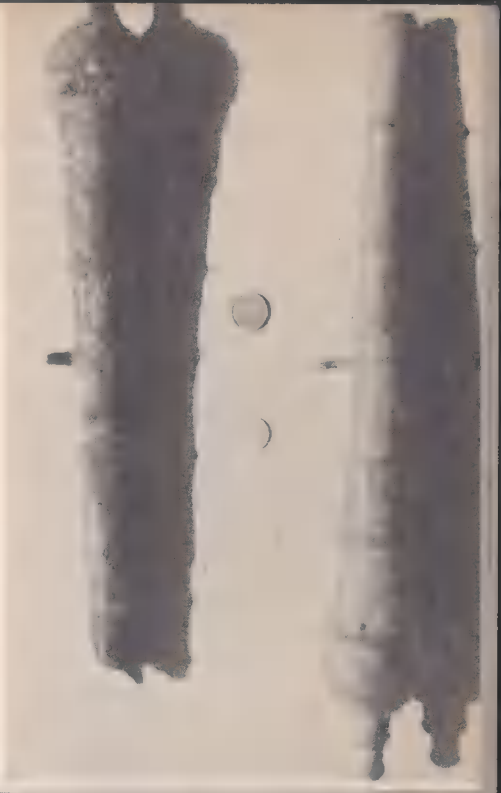

Photos by Peter Throckmorton

Above: Long before this lighthouse stood at the Great Basses reef off the coast of Ceylon, a treasure ship was wrecked there.

Right: Small cannons and Surat rupees (A.D. 1702) were the major finds of divers who explored the Great Basses wreck.

Below: Divers braved razor-sharp coral to uncover the history of Ceylon, an important link in the early European trade route.

Divers first found a small bronze gun, then a larger cannon. Finally they saw that silver coins were scattered all around the area, indicating a nearby wreck.

ACCORDING to Arthur C. Clarke, scientist, writer and now underwater explorer and photographer, Ceylon is almost virgin territory for the underwater archaeologist. He first became aware of this when he and his partner, Mike Wilson, were skin-diving off the great harbor of Trincomalee, on the east coast of the island.

In 1958, Wilson started operations on a remote and dangerous reef some seven miles from the south coast of Ceylon. The Great Basses reef, as it is called (Basses is a corruption of the Portuguese *baxios*, meaning shoal) consists of a line of rocks several miles long which lie just below the surface of the water. One larger rock, approximately the size of a tennis court, is about a yard above the waterline and is surmounted by a fine lighthouse built by the British in 1870. While he was exploring the area in March, 1961, Wilson discovered a small bronze gun lying on the sea-bed, which indicated the presence of a nearby wreck. A larger cannon, partially buried in coral, was then discovered, and almost immediately Wilson and his diving group realized that silver coins were scattered all around the area. Although they had no suitable tools, they were able to chip out about 120 pounds of silver from the sea-bed and bring this back to shore, together with two small bronze guns.

The coins were identified as Surat rupees. Most appeared to be in mint condition. All bore the same date, A. H. 1113 (A. D. 1702) and most of them were in lumps of 1,000, still in the shape of the bags into which they had been counted and packed. Later, fragments of the sacking of these bags was discovered.

A crew of Arthur Clarke, Mike Wilson, Rodney Jonklaas, some Singalese assistants and Peter Throckmorton was organized to explore the Great Basses wreck. They got a 25-foot motor launch, the usual diving equipment and two rubber dinghies.

The purpose of the expedition would be to identify the ship. Even smashed wrecks on rocky bottoms usually have bits of the hull which often make it possible to determine where the ship was built.

Although the expedition began in the calmest season of the year, big seas still broke on the reef just outside the wreck area.

The crew's first task was to make a rough survey of the site. This was difficult because breaking seas set up such strong currents that an unwary diver, unless tied to the bottom, could be swept thirty or forty

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Adapted from articles by Arthur C. Clarke and Peter Throckmorton in the spring 1964 edition of Expedition ©1964 by The University Museum of U. of Pennsylvania.

feet in either direction. Even in the thirty feet of water at the deepest end of the wreck area, it was difficult to remain in one place.

Coral rock

Little was visible through the heavy growth of coral, which had formed over the remains of the wreck, which lay in a channel between 15 and 20 feet wide, formed by two ridges of coral rock.

Once a rough sketch plan had been made, the expedition crew had a fair idea of what had happened to the ship. Running at night or perhaps in bad weather towards the land, she would have been close to the breakers before her lookouts saw anything. Perhaps there was time for an attempt to come about, and she missed stays, to go broadside onto the reef. The breakers lifted her over the first line of reef, to lodge in the valley between reefs.

The pounding surf must have smashed the wooden hull to pieces in a very short time. The heavy cannon and anchors fell through the disintegrating decks to lodge in the ravine, which was just large enough to contain the sunken ship. The upper works washed onto the inner reef, where the small swivel guns were found, and bits of wreckage probably washed right over the reef. The material from the after cabin and from the gun room and lazarette under the cabin, landed in the area of the bronze cannon and the masses of coins. Much of this material was held in place by the bags of silver.

There can have been few survivors, since life is not possible on the savage Basses reef, which lies ten miles from the nearest land and is continually swept by great rolling seas.

The divers broke out hundreds of pounds of lumps. These contained a fair sampling of material from what must have been the after end of the ship: a pair of matched flintlock pistols with brass thimbles; the forearm of a musket; a pewter decanter stopper; bits of broken blue and white china and other sherds; a bronze pestle; one gold-washed brass earring with green glass pendants; a bit of a green glass bottle; a piece of bone too small to be identified; the brass butt-plate of a musket, pistol and musket balls; and a silver-plated copper salver.

Mixed in with the mass, were pieces of coconut fiber bags in which the silver had been carried, probably a thousand coins to the bag. Every lump was full of silver coins, which had scattered through the wreck when the bags rotted. It was remarkable how much material had remained in approximate archaeological context after the wreck broke up, despite the site's exposed position directly under monsoon waves for the better part of every year.

After two weeks, the crew left the site, having raised a good sampling of material in order to identify the wreck (it might be Dutch, British or Moorish; no one is yet sure) together with several hundred pounds of silver.

How clean is clean?

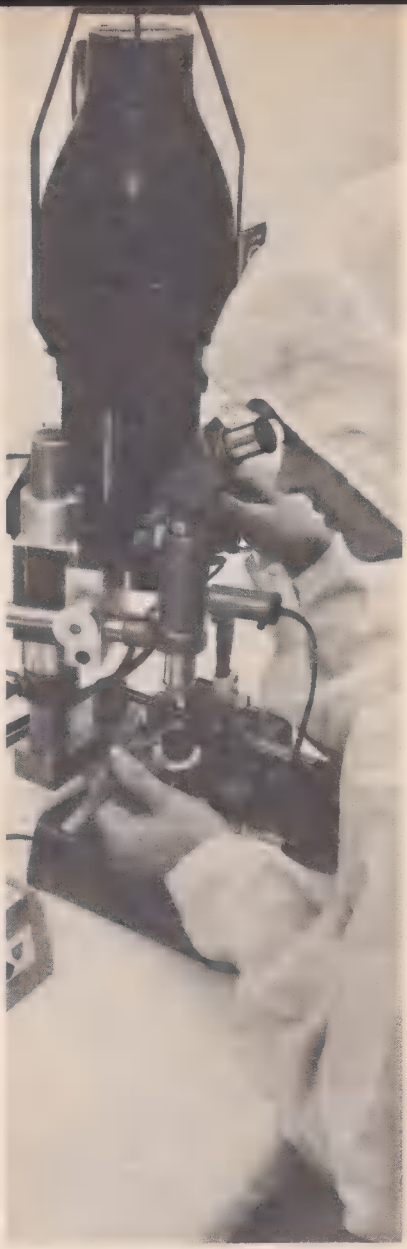
by T. J. Foster

ALL THINGS are relative. A hot stove is cool when compared with molten metal; an ice cube would be warm if compared with dry ice, which is itself warm when compared with liquefied nitrogen.

So "clean" is also a relative term. The youthful family scion may come in from an afternoon pleasantly spent on the banks of the local creek, dripping mud from every pore. After a few moments spent in the bathroom in "cleaning up"—actually spent in transferring the soil to a Turkish bathtowel—he is, in his own opinion—clean. His mother, who has just spent hours in giving her kitchen the soap-and-water treatment, thinks he resembles the bottom of a coal mine, and that he will, with no apparent effort, sully her "clean" kitchen.

Actually, her kitchen may look clean, but it would not be considered clean enough in which to perform a surgical operation. The hospital operating room, with all its devices for ensuring cleanliness, may also look clean, but it would still not be considered clean enough in which to assemble a delicate gyro or certain high-reliability electronic devices.

The hospital operating room is concerned to great extent with the problem of disinfection, and the



Inside a clean room used for assembling delicate gyro or electronic devices, workers must wear special clothing and work in an atmosphere of highly filtered air to keep dust off the tiny parts.

Reprinted with permission from *"Vectors"* published by the Hughes Aircraft Co.

use of germicides; the electronics industry has come to be concerned with environment control (temperature, humidity, pressure) *plus* - the "plus" being the control of airborne contaminants and process-induced contaminants, also called "particulate matter," or matter existing in minute, separate particles in the air. An area so controlled has been called a "dust-free area," but the term is not sufficiently inclusive, since there are many contaminants, including not only dust, but smoke, odors, even noise—because noise is a sound that moves and thus can cause dust particle motion.

The best term for an enclosed area with controlled environment is probably "clean room," though "white room" was also used several years ago, but is not as applicable now, since the dead-white walls, à la hospital operating rooms, looked so sterile they were depressing to the workers. Warmer tones are now used, in pleasing combinations.

Federal Standard 209 defines a clean room quite simply as one in which the environment is controlled —and goes on to set the standards for temperature, humidity, pressure and particulate matter in the air. The first three are comparatively simple. Temperature should be maintained between 67° and 77°F., except for special jobs requiring critical temperatures. Relative humidity should be 45 percent maximum, generally ±10 percent, except for humidity-sensitive applications. Pressure should be maintained above that of surrounding areas, so that all leakage will be *outward*—(in a reversed condition pressure would bring more contaminants *into* the area).

But the contaminants part of the clean room spec. is much more detailed, and provides a sliding scale for arriving at an answer to the question: "How Clean Is Clean?" A rule of thumb answer is that, so far as industry clean rooms are concerned, the fewer contaminant particles present, the cleaner the room. The Federal Standard divides clean rooms into three classes, according to the number of particles of 0.5 micron in size or larger in each cubic foot of air: classes 100, 10,000 and 100,000. A secondary limitation is concerned with particles of 5 micron size or larger per cubic foot: class 10,000 limits the number of this size to 65; class 100,000 to 700. Some industrial firms use their own methods of classifying clean rooms, but most methods still involve varying numbers of particles per cubic foot having dimension greater than x microns (generally 1 to 5), with secondary limitation on number of particles of larger sizes (5, 10 or 20 microns).

In the Federal Standard, class 100 is 100 times cleaner than class 10,000, and is a cleanliness difficult to achieve. The use of the micron, which is a millionth of a meter, is a more convenient notation than the inch, since one micron is equivalent to .00003937 inch (4/100,000 of an inch). To understand the size of a micron, it may be pointed out that a particle of even 50 microns

is microscopic. The smoke from the filter end of a cigarette is made up of particles of 10 microns; the human hair (.003 inch), is nearly 80 microns in diameter.

To achieve the standard, the particles must be counted periodically by one or more existing methods. This matter of sampling the clean room air is one of the most important parts of the entire operation. The Federal Standard states that all clean rooms shall use some particle counting method. There are two common methods: (1) by automatic equipment employing light-scattering techniques, for particles of .2 micron and larger; and (2) microscopic counting, for particles 5 microns and larger.

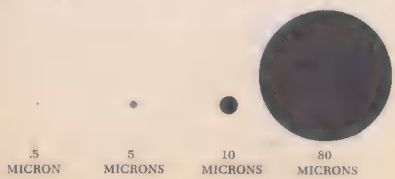
The light-scattering technique provides for a continuous sampling of the air stream. It gives indication of particle size and concentration, with instantaneous readout. In this system the light from particles in the sample stream is scattered into a phototube. The light pulses are then converted into voltage pulses, and are sized and counted in the counter's electronic system.

The second counting method uses samples taken either by settling (collecting particles in a dish coasted with an adhesive), or by filtration—passing a sample of the air stream through a membrane filter. Either method involves microscopic examination by either an optical or an electron microscope, though particles of one-half (0.5) micron in size are about the smallest that can be resolved by the optical microscope. The actual count is done by using grid squares or unit areas, counting the particles in them, and then computing the number for the entire field.

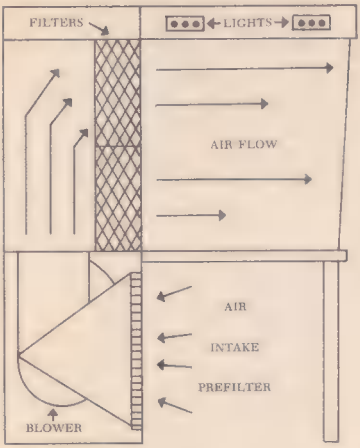
The clean room, thus, is an enclosed area with environment controlled and adequate provision for monitoring the controls. All precautions should be taken in its construction—insulation where required, rounded corners, smooth vinyl floors with minimum joints, double-glazed flush windows, fluorescent lighting and emergency exits opening from the inside only. Items peculiar to such rooms include: airlock material passthroughs, intercommunication between outside and inside, non-dusting type tables and benches and vacuum cleaner connections. For critical operations, a hooded work station with additional air filtering is necessary. This type of individual station is coming more and more into favor in clean rooms, since it offers the dust-free advantages of the "glove box" but without its hindrance to completely free access to devices being worked on.

In addition, the human element involved requires very highly spe-

Comparative sizes of particles filtered out of clean rooms. Human hair is 80 microns, a smoke particle, 10 microns.



LAMINAR FLOW WORK STATION



SIDE ELEVATION

Even within the immaculate atmosphere of a clean room, extra clean areas are needed for critical operations. In many clean rooms there is an individual work station that provides extra filtering (shown in diagram above). This type of station offers the advantages of the "glove box" plus free access to the devices being worked upon.

cialized planning. Entrances must be equipped with clothing storage areas, one for street clothing, one for dust-free clothes, with space for changing, shoe-sole cleaner mat and motorized shoe brusher. In a separate compartment is a high-velocity air shower, also called a "man cleaner," with interlocked doors. Such shower provides an air flow (30 mph is adequate) for varying intervals (perhaps 10 to 30 seconds). Clean rooms for more critical operations may have two (or more) air showers, one to be used before putting on the lint-free clothing, one to be used afterward but before entering the regular working area.

Other human factors must be taken into account. To combat claustrophobia—common among clean room beginners and caused by the many restrictions—windows facing outside hallways are necessary. To combat what has been called "clean room blues," some firms use background music systems, either continuously or at intervals.

The worker must become accustomed to the lint-free clothing, which varies in design in accordance with the degree of cleanliness desired. The ultra involves the use of complete overalls, closed at neck and wrists, with bottoms tucked in, and headcovers, shoecovers, gloves or finger cots. Less exacting conditions may require only smocks and headcovers. Neither type of garment, generally, has pockets, except for a slot for a ballpoint pen, which should be the one-piece type.

Clean room clothing is still not perfected. Heavy-weave dacron is uncomfortably warm; women have objected to the appearance of long coats on the ground that they are unflattering. As to hats, the women have found that cloth hats are warm, resulting in itching scalp and brittle hair, not to mention ruined hairdos. A remedy has been found in the use of throw-away lint-free paper hats, with some girls wearing two at a time to create a more fashionable effect. Gloves, too have been a problem, because of sweating and other discomfort. Nylon or rubber finger covers (cots) may replace them for all but the most

critical operations.

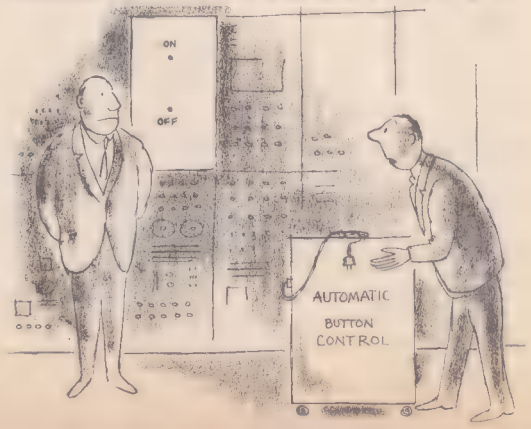
The worker, on entering the clean room area, uses the shoe cleaners, dons the lint-free attire, goes through the air shower and through an airlock into the work area. While at work, workers may not smoke, eat, drink, comb hair, or clean their fingernails. Needless roaming is discouraged because it disrupts the airflow and brings dust up from the floor. But work stations have been designed to be comfortable, with normal-level work tables, and padded stenographer-type chairs with back rests.

The "why?" for all these restrictions, regulations and costume standards, is part of the "why" for clean rooms themselves, with their rigid control of all environmental conditions, including the elimination of contaminants. The developing aerospace industry is the motivating factor, and the objective is a simple one. Contamination can have disastrous effects on reliability. It can increase friction, cause leakages, or erode moving parts. Dust particles were responsible for the fourth postponement of Col. Glenn's Mercury flight.

So the basic clean room objective is the elimination of contaminants. A better statement might be that it is to increase the quality and reliability of critical hardware—particularly items that are subject to failure because of contamination. It is essential that products be free of dust, and nowhere is this need stronger than in the manufacture of missiles, satellites, or spacecraft. An exacting control must be maintained over all environmental factors in the production, assembly, packaging and testing of critical products.

It has been predicted that, within the next five years, every firm associated with missile and space programs will require not just clean rooms, but acres of them. For the successful prosecution of the more and more elaborate, exacting and sophisticated projects daily growing in number, clean will have to be even more than clean—it will have to be immaculate!

"I'm afraid, Seymour, I have a bit of bad news for you."



What computers can do

by Stanley L. Englebardt

ALTHOUGH electronic digital computers have been with us for less than 15 years, they have progressed through three "generations."

The first generation was composed of vacuum tube machines. They came in several models and sizes. Their most notable feature—aside from the revolution they effected in business, government military and scientific methods—were the banks of vacuum tubes they contained. These tubes generated and manipulated the electronic impulses with which the computers operated. But they also gave off a considerable amount of heat and burned out occasionally. As a result, an integral part of most early computer installations was a large air conditioning system, plus the necessity for having a customer engineer or maintenance man readily available at all times.

The second generation—the so-called solid-state machines—eliminated vacuum tubes in favor of transistors, resistors, diodes and similar semiconductor components. Most of the computers presently being used—and at last count there were over 18,000 humming away in business, government military, science and industrial offices—fall into this category. They require less power, throw off considerably less heat, take up less space and are far more reliable than their predecessors. In addition, most are faster, have greater memory capacity and are generally easier to program than first-generation machines.

Today, there are about 100 different models of second-generation computers on the market, produced by some 20 different data processing manufacturers. These models range from small desk-size machines selling for under $30,000 to powerful systems, such as the IBM 7090/7094, which costs in the neighborhood of $3 million and is widely used in the aerospace and other engineering-type industries. In between are several ranges of medium-scale computers designed to handle a variety of data processing jobs.

Although third-generation computers—featuring still smaller internal components, faster operating speeds, increased memory capacity and new concepts in data processing—have been announced and will begin to be installed this year, it will be several years before a complete transition is effected.

Meanwhile the second-generation

This article is the second in a series telling the computer story in everyday language. Written at the request of Science Digest, *it details the capabilities of computers by IBM, the world's largest manufacturer of electronic data processing equipment. The writer is the author of many books, articles and television documentaries on computers.*

Most computers are built as "general purpose" machines and can be adapted to anything from writing paychecks to simulating missiles.

systems will continue to check income tax returns and maintain a history file of deductions and earnings; be used to simulate new airplanes, missiles, submarines and like objects; keep track of rental cars and trailers as they shuttle about the country; edit and prepare mailing lists for magazine publishers; write countless paychecks every week; send out even more invoices, statements and past-due notices; make sure that airline reservations are handled quickly and accurately; process stock exchange transactions; advise purchasing agents employed by thousands of firms when it is time to re-order items; tell on-duty nurses that it is time for a patient's pills or shot—and then follow up to make sure they were given; and even keep the attendance and prepare the report cards for elementary, junior and senior high schools.

Most computers, it is important to note, are built as "general-purpose machines" and can be adapted to almost any one of these jobs. This is done through programming. Thus the same model IBM 1620, a small desk-size computer, which is being used for cancer research in Philadelphia, also aids a sausage manufacturer in determining the correct meat mix for his products, tells a small petroleum refinery in Louisiana how much crude oil is needed and what products should be made from it, enables a large insurance company to custom underwrite group policies, and is used by a Virginia utility to plan power lines.

In short, it is the stored program that separates the electronic digital computer from all other types of counting devices. By storing instructions within the machine, the computer can go about its work without manual intervention. Furthermore, it can even be programmed to handle non-routine events—such as what to do with an overdrawn account in a banking system—by searching out and using an alternate instruction. In this way, the computer is able to make certain "decisions" on its own.

Larger processors

Another important element enters the picture as we move up in computer size. This is the ability to add or subtract peripheral equipment. Most desk-size computers are limited in their memory capacity and the number of input-output units which can be added to the system. The larger processors, on the other hand, aren't bound by these restrictions.

The earlier machines accepted punched card or punched paper tape input data, stored instructions on magnetic drums or cores, and recorded output either in punched

card or printed form. Later, magnetic tape input and output was added—data stored in the form of electronic impulses on metallic tape —as well as higher speed printers. And, more recently, random access storage has both increased the flexibility and capacity of many small, medium and large-scale computers.

Random access method

In a large sense, this random access method of handling data made computers feasible for virtually every business—rather than just a select few. Random access processing, introduced toward the end of the first generation, stores data as magnetic "spots" on a series of metallic disks. These disks spin around at high speeds under a "read-write" arm. In this way a particular record can be located and data can be either added to, deleted or retrieved in split seconds.

Originally the RAMAC (Random Access Method of Accounting and Control) feature was built into a single model computer specifically designed for random access processing. When the second-generation machines came along, however, IBM included it as an optional feature on all models. As a result, the use of computers as a tool was opened up to a wide range of new businesses.

Today this form of record maintenance is used widely by grocery chains, school systems, department stores, distribution firms, banks, and many other businesses dealing with large volumes of non-sequential information. Most of these users have units which feature interchangeable disk packs—each pack usually holding a different set of records. In this way they can store an almost infinite amount of information, and add it or remove it from the system as the need arises. It also means the ability to select a central processing unit to fit the job, rather than being "married" to a particular system.

Aside from random access processing, the second generation brought features such as optical scanning and magnetic ink reading. The MICR (Magnetic Ink Character Recognition) units, for example,

In 15 years the components of computers have progressed through three stages.

Third-generation machines, which will be installed this year, have pushed internal operating speeds to a range of billionths of a second.

are used by banks to "read" magnetic ink numerals imprinted today on most checks. Optical scanning devices "read" a wide range of printed material and pencil marks. Both allow direct input of data to a computer without first translating it into punched codes.

While these second-generation machines rank as a tremendous improvement over the old vacuum tube models, there is always room for further improvement. For one thing, there is a need for improved compatibility among the various size and capacity models. A firm starting out with a small scale computer, for example, can not move up to a large system without literally swapping the old model for a new one. Also, in many cases a change of this sort necessitates extensive re-programming in order to translate instructions from the "language" of one machine to another.

These problems have been solved —and many other improvements have been effected—by the third-generation machines which were introduced quite recently and will be installed starting this year.

The first of this new generation of machines, the IBM System/360, combines both new electronic technology with advanced computer concepts. The new technology comes in the form of microelectronic circuitry which, in addition to decreasing machine size and increasing reliability, has pushed internal operating speeds to the nanosecond —or billionths of a second—range.

Single-system concept

More important than speed, however, is the single-system concept of the 360. The user no longer needs to match his application to a specific piece of equipment—nor is he required to change computers as he moves up or down in computing power. There are actually over 20 different combinations of graduated speed and memory capacity possible in the system, depending on the user's needs. These combinations go from what amounts to a present-day punched card and electronic calculator system to the most powerful computer installed with the addition of only a few units.

The same compatibility is evident in programming. A series of instructions written for the smallest configuration, for example, can be run on larger systems without change. Thus the user actually saves a considerable amount of time and money as he increases his computing power.

The third-generation machines also overcome the "memory barrier" that restricts most computers today. It is the main memory, with its ability to store thousands of instructions, that differentiates a

computer from a simple calculator.

The new machines utilize a variety of memory techniques—including one called "bulk core storage." Bulk core storage means, quite simply, ultra tiny magnetic cores which are packed together more tightly than ever before. In this way up to 8,000,000 characters of information can be stored in memory, with each character available in eight microseconds. This is up to 60 times more characters than are available in present computers.

Another major feature of the third generation computers is the number of peripheral units that can be used to store, enter or retrieve information. Right now there are at least 40 different units available—with more being announced almost monthly. These units provide a variety of features:

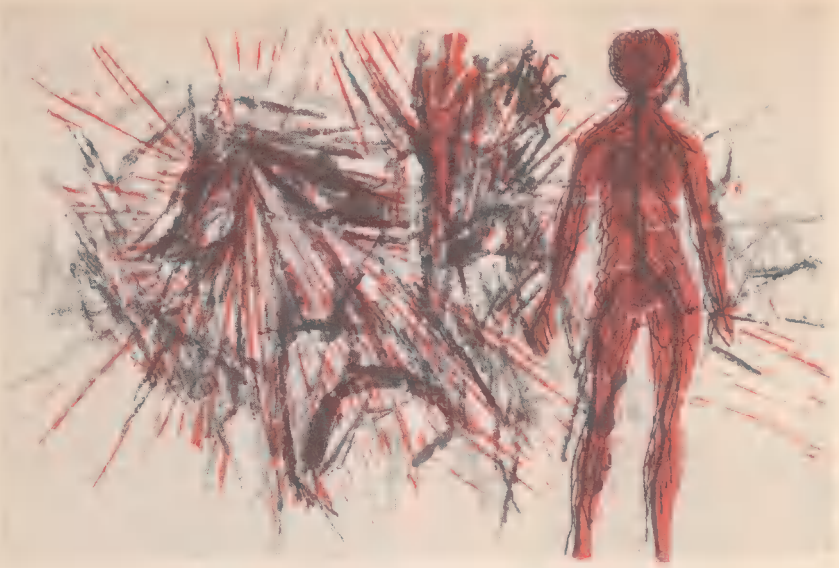
A series of units, for example, can turn a System/360 into a graphic data processing installation. One unit linked to the basic 360 can "read" graphic information recorded on microfilm and display it on a cathode ray tube; another permits changing of this image with an electronic light "pen"; still another automatically records the changed images on 35 mm film. Thus an engineering firm now has the ability to store all its plans and specifications within a computer, call any or all of them out on demand, change these plans at will and enlarge them up to 19 times.

Another series of optional units can turn the new generation of machines into a vast communications-data processing system. A device, called a multiplexor channel, allows up to 248 communication lines to be fed directly into the computer. If needed, another unit can be added to automatically scan these lines and determine the priority of incoming messages. Still another can be added to record all messages. Thus hundreds of terminals—located almost any place in the U.S. —can feed information into or take data out of the computer almost as if it were located in the same room, with the assurance that important messages will be acted on first and all information will be logged.

Still other units provide additional benefits: a new random access device, featuring a single disk which can be slipped in and out of the unit, now makes random access capability available to firms whose budgets and needs were not quite up to previous systems; new communication devices now automatically convert various codes—such as teleprinter pulses—into computer language, thus eliminating intermediate steps; and other devices now make computers available to more firms than ever before.

In the final analysis the third-generation computers are simply one more step in the advancing science of data processing.

An advanced data processing system comparable to the IBM System/360 was introduced recently by RCA. Details about RCA's and other manufacturers' computers will appear in articles to follow.



The pain clinic

Pain seems like an obvious enough thing—remove the cause and the pain disappears. But there are many types of pain where neither the cause nor the cure are at all obvious. At a Seattle hospital, doctors are trying a new approach to this problem of "intractable pain."

by Eileen Crimmin

To ALL human beings pain is both ally and enemy.

Without warning of pain in some degree, from the slight tenderness of a minor sprain to the prostrating agony of acute gastritis, we would progress to critical stages of disease without being aware of it.

Basically, pain is a life-saver. But don't tell that to a man suffering racking aches of acute arthritis or a woman dazed by torment of facial neuralgia. For them pain is an enemy.

They suffer from what medicine calls "intractable pain," which is pain that defies sure diagnosis and persists despite use of powerful medication and usual forms of treatment.

Such a sufferer, a woman, recently traveled across two continents, with a load of intolerable pain, to the University of Washington Hospital and School of Medicine in Seattle.

Inside the sprawling pale brick building was the clinic to which Marie had been sent by her doctor, the last in a long list of doctors. It was no secret between them that if this clinic could not diagnose and relieve the agony coursing through her left arm there was no other place in the world to seek relief.

Eagerness and hope

Knowing this, Marie, like all intractable pain patients, approached the hospital with eagerness and hope, yet steeled to possible failure.

The pain clinic Marie entered has no suite of rooms, no printed shingle or card and no formal office hours. In fact, it is more concept than clinic. It has formal existence only when a case confronts it. The staff, specialists from diverse medical fields, meets after a case is undertaken. Its method resembles consultation, but goes far beyond the usual boundaries and limits set upon consultation activities.

Like every patient, Marie gave the clinic all her previous medical history including diagnoses, treatment and prognoses. These were distributed to the staff for study. Meanwhile, appointments were made for each specialist to examine her and conduct whatever tests were considered necessary.

Examination is time-consuming, often a matter of days. But it's also a major precept upon which the clinic is founded. With staff composed of specialists in radiology, therapy, physical medicine, surgery, orthopedic surgery, neurosurgery, anesthesiology and psychiatry, examinations given present a broad base for diagnosis. Summarized, the total information gained is overlapping, but it is also minute in detail, exhaustive and necessary to the final actions of the clinic. These actions are based on findings evolving from a staff gathering around a conference table.

In Marie's case, her prior histories showed that following radical mastectomy (removal of breast and glands for cancer) and cobalt radiation treatment, Marie sustained in her left arm unbearable pain that wouldn't yield to drugs. Previous diagnosis suggested the pain was "hysterical" reaction or a suspected return of malignancy, even though none could be found!

As Marie saw it, she'd been told that no matter how miserable she was, there was no reason for it. And a "hysterical reaction" diagnosis is tatamount to being told "you hurt because you're badly upset. You're causing your own pain." Small comfort and no relief.

Now, at the staff meeting in Seattle on Marie's case, each specialist offered the results of his examinations. He presented both his findings and the causative pain possibilities inherent in each of them.

From this free-wheeling discussion, a new diagnosis evolved. They decided that the cobalt radiation treatment had scarred Marie's arm nerves sufficiently to perpetuate pain.

Does the pain clinic offer medical miracles? Patients relieved of torture say "yes." Staff doctors, who are horrified at the word, say "no."

Treatment? Each specialist had available all therapy in his field. Certainly the neurosurgeon could sever the damaged nerves and end pain forever. But this would result in loss of sense of touch, possibly some loss of arm function.

The psychiatrist objected. Try something less severe. Mastectomy generally leaves the most stable patient with a sense of mutilation. Additional loss of touch or function, despite pain relief, might increase that sense. Why risk it unless there was no other answer?

Exchange of ideas

From a peppering exchange of questions, objections and ideas, a final recommendation evolved that alcohol injection in the proper spinal area would render ineffective those nerves sending pain signals to the brain. The injections would neither impair nor reduce other functions.

Agreed? Agreed. The treatment was outlined for Marie's approval, then carried out. Her relief from pain was immediate and dramatic. Her arm functioned normally. In subsequent check-ups, Marie remained free of pain. She returned home and presently pursues life with fullest enjoyment.

In Marie's case, the clinic recorded a complete cure, the kind that grapevine exaggeration calls a "miracle." Does the clinic offer medical miracles? Patients relieved of torture say "yes." Staff doctors, horrified at the word, say "no."

No new drugs or methods

They've discovered no new drugs or methods. They've merely combined all known methods and drugs into concentrated attack upon each case they meet. If any "miracle" exists, it's in this idea.

Like most progressive ideas, it resulted from one man's horror at intractable pain suffering he saw in a veterans' hospital. Dr. John J. Bonica, anesthesiologist, began a war on pain which he has pressed from that day to this. Together with neurosurgeon Lowell White, he co-directed the pain clinic to its present success.

Not all the clinic's more than 100 cases are as bright as Marie's. But the over-all fine record warrants establishment of others at medical centers throughout the nation. Why medical centers? Because only there are found the variety of specialists necessary to form the staff. Other pain clinics—headache, arthritis, cancer, etc. — deal with only one type of pain, need only one type of specialist.

The Bonica-White clinic is unique —a pioneer in treatment of all

types of intractable pain. Even so, the clinic soon discovered that four types of pain dominate its records.

1. Cancer-caused pain.
2. "Reflex sympathetic dystrophies" better known to laymen as "referred pain," or pain not felt in the area of origin.
3. Pain following injuries; i.e., healing of fractures where, though bones are set properly, pain remains vicious.
4. Pain from visceral disease; chronic pancreatitis, colitis.

A referred pain case arrived in the form of a middle-aged construction foreman, Jim, who presented intractable pain of the left wrist and hand. Onset of suffering followed proper healing of a Colles' fracture, a break of the outer, shorter forearm bone (radius) often resulting in backward, downward displacement of the hand. The staff examined a cold cyanotic (bluish) perspiring left hand reacting painfully to both pressure and movement.

Observing the clinic's rule of trying to remove "primary cause" of pain, X-rays of the healed fracture were ordered to see if the bone had knit properly. It had. The X-rays also revealed mild osteoporosis, a porous bone condition due to absorption of calcareous material, but which in itself was insufficient to cause the degree of pain Jim felt.

In summary, the doctors decided Jim suffered referred pain. Nerve blockage was recommended and carried out. Again relief of pain was dramatic and follow-up examinations showed no recurrence of symptoms.

Visceral pain

Visceral pain often is most baffling for a clinic or individual physicians. When short-lived, as any stomach ache victim can testify, an irritated viscera makes its ambivalant sufferer first fear he will die, then fear he won't!

But chronic, severe visceral pain offers neither ambivalence nor humor. It depletes its victim physically, mentally and emotionally. Its ravages can so profoundly alter a patient's personality that family and friends regard him as a stranger.

Diagnosis is difficult, treatment complex. Take the case of 42-year-old William. For two years he'd struggled against constant agony in his middle. Since pain was predominately on William's left side his own doctor finally narrowed the problem to an "epi-gastric pain occurring as a sequel to hemachromatosis."

The fancy words meant William hurt in his upper left digestive system following treatment for one of the many forms of diabetes. By the time he checked into the clinic the diabetes was arrested by proper treatment.

First nerve blockage was done. When its pain relieving effects were observed and knowledge gained about which portions of William's nervous system were trans-

mitting pain signals from digestive tract to brain, a "transthoracic splanchincectomy was performed with resection of the greater, lesser and least splanchnic nerve." In plain words, nerve surgery halted the pain.

Follow-up

Follow-up revealed no recurrences and William was back among the living again — the comfortably living, that is.

A portfolio of cases shows that the clinic's pain relieving methods include all those from the country doctor's beat-up bag, beginning with application of heat and cold, minor to moderate exercise, massage, then elaborating into narcotics, barbiturates, nerve blocks, nerve severance and other complex therapies.

Along with the old therapies comes an old concept, but newly applied—psychiatric counsel for patients whose relief never will be complete. They must learn to live with reduced, not banished, pain.

Dr. Bonica explains that "pain is a highly personal affair, entirely subjective in nature and a complex phenomenon which almost defies inquiry."

Simply, what hurts me doesn't hurt you. And what sends me yelping to the doctor is only a twinge you shrug off with annoyance.

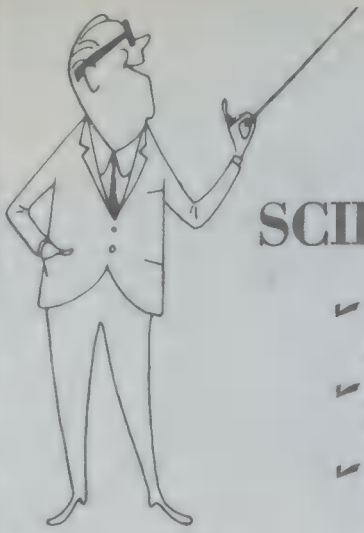
Add to this the complexity of psychic and physiological factors and you have a problem general practioners cannot explore fully.

It's here that the group attack shows so much promise. Precisely how successful is this concept? "We have perfect cures and perfect failures," says Dr. Bonica, "but the majority of cases close between these two extremes. Pain management is time-consuming, ten days sometimes just for diagnosis. Then treatment, especially psychotherapy, can be slow. But to help at all and relieve even a little of a patient's pain is a great stride forward."

When continued pain distorts the sufferer's personality and upsets life around him, it may be just that small amount of relief which restores a patient to usefulness, to being the person he once was.

Snail signals

A SNAIL is attacked, and other snails of the species crawl into the sand as an "alarm" travels through the water. This phenomenon of snails giving off a "fright substance" to "warn" other snails is being investigated by a Cornell University researcher. In his laboratory, many small aquariums have been set up as test chambers, and fishes, turtles and crayfishes are kept as predators. Actual attacks are carried out and the results analyzed. Among some species, the substance given off by an attacked snail sends others digging into the sand. Attacks among other species send members of their kind fleeing from the water.



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This man is composing music

In the strange new field of electronic music, brought about by the combined efforts of engineer and composer, anything is possible.

by Bruce H. Frisch

DR. MILTON Babbitt (left), professor of Music at Princeton University, danced along in front of the $250,000 RCA Synthesizer, twisting knobs, flipping switches, plugging in wires.

He was composing electronic music, a strange new field that blends science and art by producing and mixing tones electronically.

Electronic music isn't an example of a takeover by machine, Dr. Babbitt puffed between electronic adjustments. It is just the opposite.

"This monster doesn't do anything," he said. "The composer has to specify everything. This poor dumb animal just sits here."

In fact, composing electronic music, according to Dr. Babbitt, makes greater demands on the human than composing regular music. Every characteristic of every fraction of a second of sound has to be created all or in part electronically and pieced together on tape.

Practically anything is possible. But complete freedom puts a terrible strain on the musical imagination and can leave the composer wandering aimlessly.

"You have to limit *yourself*," says Andres Richter, an Argentine electrical engineer and composer.

Musicians have chosen different kinds of limits. One group, led by a French technician, Pierre Schaeffer, uses only natural sounds. If any single person can be said to have begun electronic music, it is Schaeffer. In 1948, he recognized how the flexibility of the newly invented tape recorder would allow him to twist, sounds into what he called *musique concrete*. Virtuoso pieces have been put together out of a single flute note, or the single spoken syllable, "ah," or a single cymbal stroke.

Six years later, another school sprang up in Cologne, Germany. A group of young composers who had run through most of the avant-garde movements, devised their own, *elektronische musik*. They use only sounds created electronically, and usually only pure tones of a single frequency. Some of their written music had been too difficult for a live musician to play. Through electronic music they could finally hear their ideas performed.

Otto Luening and Vladimir Ussachevsky learned the tape techniques in European studios and carried them to America. They are now at the Princeton U.—Columbia U. Electronic Music Center in New York, which is the most prominent

Vladimir Ussachevsky, left, and Otto Luening in a conventional studio.

in this country. There are smaller studios at Yale, Brandeis and the Universities of Illinois, Michigan, Wisconsin and Pennsylvania.

Americans have an "anything goes" attitude. They may combine natural sounds electronically modified, purely electronic tones and human performers in the same piece. They avoid the European absolutes, each, instead, defining his own personal musical limitations.

At the Center, composers have two studios of the kind in which about 90 percent of the world's electronic music is created, and the Synthesizer.

A composer working in the conventional studio dials the tone he wants on a variable oscillator. Instrumental sounds are made up of a mixture of many tones. The tone with the lowest frequency is the fundamental. Tones with frequencies which are whole-numbered multiples of the fundamental are harmonics, or overtones. It is the mixture of harmonics and their relative intensities, the sound spectrum, which gives each instrument or voice its characteristic timbre or sound.

A composer can mix up his own recipe of harmonics from his battery of oscillators to get any sound he wants. This is called additive synthesis.

In practice it is easier to start with a sound rich in harmonics and remove the unwanted ones. This is called subtractive synthesis.

"White noise," a hissing sound, contains every audible frequency. It becomes the ingredient of thuds, bangs, cymbal-like sizzles, anything with a noisy quality. Musical sounds contain only harmonics; noise also contains frequencies between the harmonics

The raw material for a musical sound may be a sawtooth wave, which contains all the harmonics, or a square wave, which contains every other harmonic. A fourth possible starting point is any recorded sound from the smash of a breaking bottle to a guitar plunk.

The raw material is fed through filters where unwanted frequencies are carved out and others muted. Then, in a reverse operation, resonators strengthen desirable harmonics.

The attack and decay times of a tone can be more important than timbre in making an instrument in-

stantly recognizable. Attack is the speed with which a tone builds in volume; decay is the time for it to fade. An organ, for instance, has a slow attack and a guitar has a fast attack. A composer can vary the attack and decay in a crude way by twirling the volume-control knob of the amplifier. He can do it much more precisely by making a diagonal splice in the tape, or by using a circuit that has the effect of twirling the knob electronically. By snipping the tape straight across, the composer can get a sharp cutoff or abrupt beginning.

A completed tone goes on tape, where a new round of manipulation begins. Many notes can be recorded on top of each other. The speed can be doubled or halved with the usual two-speed tape recorder. With a speed control for the tape drive, any ratio is available over about an eight-to-one range.

A tape deck with two heads can create an echo effect. The second head picks up the sound previously recorded on the tape and feeds it back to the first head where it is re-recorded over the original sound with a slight time lag and reduced volume. The second head then picks up the echo and starts it around the circle again. The time it takes the echo to die out depends on how much the volume is cut during the rerecording phase.

A related, but different, effect is achieved by sending sound through a reverberation chamber. The emerging sound can be adjusted to give one the feeling of being in anything from Yankee Stadium to a phone booth.

A composer may want to modify a sound he has already used or has recorded from life. He cuts out the portion he wants to use and splices the ends together in a loop. The

Recently it took Dr. Babbitt five to six months to finish his 12-minute "Ensemble for Synthesizer." It can be played in only one place.

sound plays over and over as the composer experiments. The loop can also lay down a repetitive background pattern.

When the composer has shaped every component sound of his piece, he begins the slow task of splicing them all together. About 70 percent of the time spent on a piece may go into splicing. By measuring the length of each section of tape, the composer can control intervals.

The Synthesizer eliminates a good deal of his tedious splicing and much of the manual setting of the electronic tools.

Before sitting down at the Synthesizer, Milton Babbitt writes out his whole composition in his own shorthand. There is no accepted notation for electronic music.

He "plays" this composition on the Synthesizer keyboard. He is really punching instructions into a wide, moving roll of paper. Later, Babbitt simply flips a switch to start the paper rolling and the Synthesizer creates the sounds called for and records them on tape. Theoretically Babbitt could punch out a four-channel piece on the Synthesizer's two keyboards direct from his score, flip the switch and have a ten-minute composition completed on tape ten minutes later. In an actual recent case, it took him five to six months to finish his 12-minute *Ensemble for Synthesizer.*

At the heart of the Synthesizer are twelve electrically-driven tuning forks, one for each tone in a conventional scale. The composer punches in his selection of one of the twelve tones and punches again for the octave into which that tone should be electronically converted. He punches more holes for timbre or sound spectrum, envelope or attack and decay, volume, and tremolo. The Synthesizer produces tremolo by varying intensity from two to 30 times a second. A singer creates vibrato by also varying frequency and spectrum. These can be duplicated on the Synthesizer, but with added difficulty.

In addition, the Synthesizer has twelve variable oscillators, a frequency glider for swooping smoothly from one pitch to another and provisions for a whole battery of other tricks and conveniences that make it much harder to master than may be apparent.

Milton Babbitt is the only composer to do so. Everyone else needs the aid of technician Jame Searight. "I am the beast's keeper," he says.

Babbitt composes for the set-up in Columbia's McMillin Theatre, where he can send 12 tracks of music out through speakers all around the hall and in the ceiling. A piece will never sound the same anywhere else or on records. "When we have to put on a performance in public

[elsewhere], we are terrified," says Babbitt.

Although the Synthesizer can create any weird new sound imaginable, "composers don't come to it for a new sound," says Babbitt. "New sounds lose interest quickly. They're mainly interested in problems of time." With the Synthesizer, or even with the regular methods of electronic music, they can perform new feats of control of intensity changes, timbre and rhythm changes, fast tremolos, different simultaneous rhythms, and so forth.

The only machine that can outperform the Synthesizer is the digital computer. Two centers of experimentation are at Princeton University under James Randall and at the Bell Telephone Laboratories in Dr. Max Mathews' Behavorial Research Laboratory.

A composer's instructions are transferred to punched cards which direct the digital computer in turning out a series of numbers. Each number represents the height of one bar on a bar graph. A line drawn over the tops of the bars follows the shape of the sound wave as it would appear on an oscilloscope. A digital-to-analog converter changes the numbers to voltages for driving a speaker or recording magnetic tape. The bill for this process, Mathews estimates, runs $2,000 to $3,000 for an hour of two-track tape.

Instructions can be stored in the computer memory beforehand, describing the sound of a real or imagined instrument. All the notes called for on the punched cards will then sound as if played on this instrument.

Bell has used the computer to delve into what might be called "composing in generalities." Instead of slogging along note by note, the composer gives the computer the big picture, the trends of things like pitch and tempo that he wants to use to create an overall effect.

At Bell and Princeton, the output is finished sound. Lejaren Hiller, at the U. of Illinois, has concentrated on computer-composed music in written form for regular instruments. The computer can follow strange rules of composition more objectively than a live composer with old habits and prejudices.

One outcome of these methods of complete control are discoveries in psychoacoustics, the science of how we interpret sound.

Mathews seeks these things out very systematically. He has found that perfect execution is tiresome, but randomness adds richness. On the other hand, random notes are boring; music must generally seem to have a direction to hold interest. One Bell experimenter stumbled across a series of sounds that seems to be constantly ascending (or descending if the tape is reversed) but is really running through an endless cycle.

Knowledge like this, Mathews feels, will help guide future composers in exploring the limitless possibilities of electronic music.

"Courses in musical acoustics," he says, "will be just as prominent in their education as counterpoint."

Now we're drilling for steam

A big source of power has been discovered in California. It's underground lakes of high pressure steam created by volcanic activity.

by John L. Parker

A TEXAS wildcatter drilling for oil near the Salton Sea in southern California ran his drill point into what may be the largest underground teakettle in the world. Last January, Pure Oil Company celebrated its 50th anniversary by drilling the world's deepest and hottest steam well. Shell Oil Company has since completed a well in the Salton steam play, too, and is now drilling two more steam wells.

The Pure Oil steam well is 8,100 feet deep and is the first to be discovered with bottom-hole temperatures above 700 degrees F. These developments in this new geothermal area make it a major source of potential underground power supply.

Just what is geothermal power, and how does it operate from steam wells?

Geothermal means heat of the earth, and geothermal power refers to a method of using the steam which is generated underground and pours to the surface through wells, to produce electricity.

The principles of steam power generation are the same whether applied to a tea pot, a coal fired steam boiler or the earth itself—the requirements are simply heat, water and a closed container in which water can be heated to form steam under pressure.

Geothermal power is created by magma, high-temperature rock usually found only at great depths in the earth below water stratas. Geothermal power results when this molten rock layer occurs nearer the earth's surface, a condition usually associated with recent (geologically speaking) volcanic activity.

Instead of a kettle or a forced-draft, fuel-fired boiler, a porous and permeable layer above the magma contains a source of water which is heated above the boiling point by the molten mass below.

The lid for this tight container is a layer of impermeable rock which holds the heated water below it under such great pressure that it remains in liquid form even at temperatures above the normal boiling point of the water.

When deep well drilling pierces this thick lid, the water flashes into super-heated steam surging up the well casing where it can be harnessed into power through pipeline feeding high speed dual stage turbine generators.

Steam well prospecting techniques are similar to those used in drilling oil wells. Locating promising geothermal reservoirs takes much the

Pure Oil president, vice-president-field manager for Earth Energy, and drilling supervisor inspect Pure Oil steam well.

same geophysical and geological skills used in successful oil prospecting.

This potential new power source is low in cost. Electricity produced by geothermal power is up to 25 percent less expensive than coal or petroleum powered generation.

The United States is one of the last countries in the world to begin development of geothermal power sources.

Italy pioneered the use of geothermal power before World War I from small wells drilled into natural underground steam pipes near Florence. The generating facilities were destroyed during World War II and later rebuilt. Today this field generates sufficient electricity to supply a city of 600,000 people. Italian scientists estimate reserves of heat sufficient for 11,000 years at the present rate of use.

New Zealand second

New Zealand, the second country to harness geothermal energy, started operations in 1958. Its present 129,000 kilowatts of power will be ultimately expanded to 1 million kilowatts or enough for a city of 2 million. New Zealand uses much of the geothermal power in the manufacture of paper, utilizing the steam for electrical generation and exhaust steam from the turbines to dissolve the wood fibres in the pulp.

The Salton Sea field, of approximately 15 square miles, is considered by far the most spectacular discovery of geothermal energy in the United States and, perhaps, the world.

Salton Sea thermal wells are unique in that they are the only wells ever drilled which yield a mixture of steam and saturated saline water or brine, which must be separated before the steam is used for power generation. This is somewhat of a mixed blessing. The brine contains valuable minerals which can be recovered, and sizable quantities of waste material. With power generation at the wells, recovery of the mineral and chemical values becomes economically feasible. However the huge mass of waste

material requires disposal and this is something of a problem in this great flat, semi-desert country which is as much as 100 feet below sea level.

The flow from the wells consists of 30 percent steam and 70 percent brine.

The average production from the flow of one Salton field test shows a total maximum flow of 2,080 tons per day. This, broken down into main components is 1,120 tons of NaCl (sodium chloride), 324 tons of KCl (potassium chloride suitable for fertilizer), and 636 tons of $CaCl_2$ (calcium chloride) per day. Other values which have been found in the brine include iron, boron, manganes and trace elements.

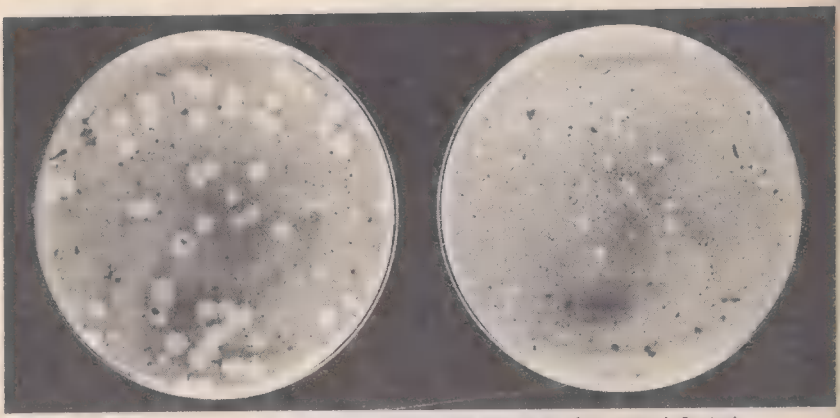
To develop the maximum use potential from company leases in the Salton field, Pure Oil has created a subsidiary organization, Earth Energy, Inc. which is cooperating with Magma Power Company and pioneer in thermal development in the West. Between 1955 and 1957 Magma and its associate, Thermal Power Co., drilled in six steam wells at the Geysers, a hot springs spa north of San Francisco. The wells are now providing steam for two electric generating plants generating 28,000 kilowatt-hours, enough for a city of 50,000. This is now the only geothermal powered plant in the United States.

At the Salton Sea field, Dr. Carel Otte, vice president of Earth Energy, heads a group of technical experts who have perfected a successful low cost method of separating the steam from the wet brine and holding the brine for recovery of the mineral values.

Shell Oil is also engaged in a comprehensive technical study to evaluate the economic uses of the steam and the brine for control, processing and marketing. Shell is working with several research organizations in development projects.

The brine which gushes from the wells is curiously similar to the brine pumped from Owens Lake at Trona California and processed by the American Potash and Chemical Corp. In a series of complex fractioning steps involving centerfuges, gravity and filtration under varying degrees of heat and pressure, American Potash produces a variety of marketable products including pure boron, lithium, potash, calcium and manganese. Many experts believe that somewhat similar recovery methods can be successfully applied to the vast quantities of mineral rich brine ready to spew out of the Salton Sea Wells.

Salton Sea thermal wells yield a mixture of steam and saturated saline water, or brine.



The results of Interferon, an anti-viral protein, are shown in these two infected cell cultures. The culture on the right was treated with Interferon.

Wanted—drugs to fight the new viruses

by Bill and Nellie Slaton

In Burlingame, California, a three-and-one-half-month-old baby boy died from meningitis. The family confirmed the fact that a week earlier, a soldier from Fort Ord had visited them. An attractive newly wed woman was stricken with meningitis after visiting her soldier husband at Ford Ord. Congressman James Roosevelt's office was bombarded with phone calls from irate parents demanding that their sons be taken off the list of new recruits scheduled to go to Ft. Ord. Letters poured into Governor Pat Brown's office from citizens living in the shadow of Ft. Ord requesting a shutdown of the barracks after some of the citizens became ill with meningitis.

What had happened?

Powerful sulfa drugs that used to completely knock out meningitis were no longer as effective. A drug-resistant meningoccus had appeared.

Dr. Dan Ivler, Director of Microbiology at the Infectious Disease Laboratory of U.S.C. School of Medicine, and his associates have demonstrated in their studies that some sulfadiazine-resistant meningocci secrete an excess amount of paraaminobenzoic acid-like material which interferes with the action of the sulfa drug. Strains of this germ were isolated from the throats of patients and healthy carriers at U.S. Naval Training Center in San Diego. In 1963, a series of meningitis outbreaks swept the San Diego Naval Training Center.

Sulfa plus penicillin is effectively

used in the treatment of the disease but the aim of the physician is to eliminate the germs in the carriers.

For example, in Sudan Africa a team of physicians and technicians from WHO (World Health Organization) gave sulfa treatment to a whole village of natives to protect them from meningitis and to kill the germs in the natives who were carriers. The World War II epidemic was successfully snuffed out by giving all servicemen the "new" wonder drug sulfadiazine. Until a year and one half ago sulfa was highly effective in wiping out the organisms in carriers . . . then the meningoccal germ gradually became resistant.

Meningitis is an inflammation of the membrane covering the brain and spinal cord. Patients who recover could have disabilities such as paralysis and deafness.

The three types of meningitis or "spotted fever," can be caused by fungi, bacteria or viruses. We are concerned with the epidemic type due to bacteria known as meningoccal meningitis. It runs roughly in eight-to-twelve-year cycles. Since it only infects man, human carriers are the cause of spreading the disease. It is called a disease perpetuated by overcrowded conditions.

In a recent interview at his office on the grounds of General Hospital, Dr. Ivler said that there were three kinds of meningitis carriers: the chronic carrier who carries the germs for a year or more, the acute carrier who after recovery carries the organisms for only several months and the convalescent carrier who carries the organism only during the disease and convalescent period. Dr. Ivler said that from one to ten out of every one hundred people are would be carriers of the meningitis organisms.

More soap, less penicillin

In recent years, medical men have encountered penicillin-resistant staph, streptomycin- and isoniazid-resistant tubercle bacilli, penicillin-resistant gonococci and many others.

In an effort to conquer this problem of staph, hospital personnel were urged to use more soap and water, to cut down on the use of penicillin and to give an adequate dose of the drug so that even the most resistant organism would be killed.

It seems that the staph germs exuded an enzyme called penicillinase which prevented the penicillin from being effective. At present, synthetic penicillin is being used. It is more potent than the original natural penicillin.

For tuberculosis, the drug-resistant cell is conquered by giving the patient a combination of drugs such as streptomycin, part-aminosalicylic acid (P.A.A.) and isoniazid. Large doses of penicillin proved effective in cases of gonococcus. Streptomycin and tetracyline have also been used.

There is a great deal of interest among scientists about the development of drug-resistant germs. The ability of this cell and its offspring to remain alive and even multiply under adverse conditions is a chal-

lenge to the world of science and medicine. According to microbiologist John N. Porter, who works in the Biochemical Research Section of Lederle Laboratories, this phenomenon has been observed in protozoa, bacteria, fungi, viruses and cancer cells.

In the laboratory scientists subject the cells to x-ray, ultra-violet rays, radiation, different kinds of acids, inhibitory drugs and other techniques. In the process, the majority of cells sensitive to the particular medium die and only one or two hardy ones live. These are called mutants because they were able to resist or adapt to their abnormal exposure.

Immune to drugs

Some microbes through a process of natural selection become immune to the drugs. Staph emitting penicillinase have always been around, but now there are more of them, while other microbes adapt to the drugs like the meningocci secreting an abnormal amount of P.A.B.

Scientists working for drug firms are especially interested in finding out "why mutations to resistant cells occur, how they may be prevented from occurring and in what ways drugs actually kill a cell or prevent it from multiplying further," said Porter.

Other investigators study the natural mechanisms of the human body that seem to control the spread of bacteria and viruses.

The virus presents some very special problems. All viruses are highly refined parasites. Hundreds of viruses can result from the union of a single virus and a single cell. The virus must penetrate the cell in order for the cell to become infected. Most interesting is the fact that once a virus is inside, other viruses cannot enter. Medicine's most important weapon against the virus has been the vaccines such as the Sabin polio vaccine.

Dr. Samuel Baron has successfully produced Interferon in the laboratory.

The first anti-viral drug marketed in the United States was idoxuridine or I.D.U. I.D.U. was actually an experimental cancer drug that was used with success by a Florida physician in the cure of vision-damaging infection caused by the herpes virus.

Since this anti-viral chemo-therapeutic breakthrough others are gradually being developed for combat. While the list of effective anti-viral drugs grows, the investigators and doctors are aware of the unfortunate experiences resulting from

drug-resistant bacteria.

One of the most fascinating discoveries in recent times has been the isolation of a substance called Interferon. In 1957, Dr. Alick Isaacs and Dr. Jean Lindemann at the National Institute of Medical Research in England isolated a virus, interfering substance and named it Interferon.

Nucleic acid protein

Interferon is a protein known to be a nucleic acid protein that is a natural product of all living cells which protect themselves against viruses. Although it is in the early experimental stages, Interferon shows great promise in the natural control of viral diseases.

Unlike vaccines, Interferon does not induce antibody production in the body. This is a most important asset, because Interferon can then be administered as frequently as necessary without its effects wearing off. Once a virus makes its entrance in the bloodstream, the alarm is sounded and the body begins to send out Interferon. The Interferon, however, seems to wait until the invading virus is within the cells before it goes into action. Then it penetrates the cells, thereby erasing the blueprint for making more viruses.

Interferon is more prophylatic than curative since damaged cells that cannot be restored by the body, such as nerve cells, remain damaged.

While much is yet to be learned about Interferon, one of the major problems is producing more of this precious substance. Investigators are working on this problem. Interferon is essentially species-specific. That is, if its source is human tissue, it will be most effective against infection by a virus in the human tissue. The most practical solution to the problem is that of inducing or stimulating the body's production of Interferon.

Clinical tests with monkey Interferons in human beings have already been run in Great Britain by the Medical Research Council in collaboration with three pharmaceutical firms with some degree of success. Interferon was found to produce a highly significant degree of protection.

Experimental substance

Dr. Samuel Baron of the Laboratory of Biology of Viruses at the National Institute of Allergy and Infectious Diseases is producing Interferon in the laboratory.

Although he is very optimistic about the future of Interferon, he says, "Interferon is still an experimental substance and if it ever becomes useful in man, it has a long way to go."

Beyond all the new research, one thought persists:

The fact that we stay well in spite of staph, pneumococci, and alpha strep germs in our throat, the normal amount of staph germs on our skin, not to mention our constant exposure to germs every day, is a miracle in itself.

NBC Photo

The Hugh Downs Column

The vision of Father Pierre

THE apparently indestructible human need to believe in the occurrence of irrational miracles puts us in the position of the fool who went in search of fire with a lighted lantern. Had he known the nature of fire he would have realized the vanity of his search. Since our *belief* is a miracle—since our existence is a miracle, the trees get in the way of our seeing the miracle of the gigantic forest of Existence. But every now and then a human appears who is tall enough and who stands still long enough to look out over the tops of these trees and observe the forest. If he observes a great deal, and does so accurately, he is a scientist. If he also extracts patterns, trends, *meanings* from what he observes, he is a wise man.

Such a man was Pierre Teilhard de Chardin, who died in New York in 1955. Born in Auvergne, France in 1881, Pierre was destined to become first a Jesuit priest and then one of the foremost anthropologists of his age. (Among other accomplishments, he was the co-discoverer of Peking Man). In the course of his anthropological and paleontological studies, he began to ask himself what the emergence of the human species meant, whether evolution is at an end, and what the far future has in store for living matter.

Copyright by Philippe Halsman

Pierre Teilhard de Chardin

Life's ultimate aim, Teilhard de Chardin says, must be to reduce its dependence on the physical universe to the vanishing point.

Teilhard de Chardin, after gathering together a veritable mountain of learning, by prodigious effort put it into sound perspective in a manner understandable to those of us without the background of a lifetime of study in several scientific disciplines. After this formidable task, he postulated and offered proofs for an idea more earth-shaking than Einstein's, an idea that bids fair to provide a common and compatible roof for cosmology, religion, humanism and common sense.

Like Einstein, he didn't do it single-handed. Many of his thoughts will be found in the works of other anthropologists. Where Einstein stood on the shoulders of Reimann, Lobachevsky and Clerk Maxwell, Pere Pierre stands on those of Darwin, Boaz, Osborn, Huxley and Bergson.

Can you make a simple statement about what a man has done in a lifetime of painstaking (and in his case, truly agonizing) work in a difficult field of great depth and breadth? I'm going to try.

By scientific methods, Teilhard de Chardin showed that evolution has not ended, that it has a direction, and that humanity can justify an optimism concerning the future.

If you choose to follow him into the forest, I advise against packing along scientific or religious prejudices or cherished dogma because you're apt to lose them before you get out.

The first miracle is the existence of Life. In a universe dominated by the Second Law of Thermodynamics (which demands that order must eventually disintegrate to chaos, in other words that all local conditions must dissipate their character into a general "random-ness"), the appearance of living matter (which must have higher levels of chemical organization than inanimate substance) is a miracle to begin with. That it would develop from low forms into higher and more complex forms is another miracle and an embarrassment to the Second Law of Thermodynamics.

It may be that definitions of "life" are fatuous when we draw lines as to when complex chemical actions leave off and simple life begins. These lines are arbitrary. Let's assume for a moment that "life" began when the first proton, a nuclear particle, captured the first free electron and formed a hydrogen atom.

Crudely traced, we have evolved from the hydrogen atom somewhat in this fashion: Quintillions of quintillions of hydrogen atoms, milling in space, form clouds which collide and swirl and behave according to the laws of gravity and magneto-hydrodynamics, forming on occassion a cloud large enough to represent a significant gravitating mass

which falls in upon itself, packing the atoms at its center so tightly they form a very dense gas, radiating heat and light. This is a star. Very large stars forge heavier elements out of this hydrogen at their centers, stripping electrons off and packing nuclear particles until all the elements up to uranium are present. Explosions occasionally rip these giants asunder and spew forth these elements, which may condense into solid masses of various sizes, and some of which may find themselves satellites of stable stars at distances that allow compounds such as water to be liquid most of the time.

Where this condition exists, and where carbon exists because carbon has the almost mystical property of combining with other elements to form fantastically complex chemicals in the temperature and pressure range where water is liquid, the sheer weight of numbers and expanses of time bring about the opportunity for considerable chemical experimentation.

"Organic soup"

Electric activity in the atmosphere (lightning) and radiation bombardment synthesized some of the chemicals necessary to form an "organic soup" in the early seas.

Haldane painted the picture of a primeval ocean, "lifeless, but murky with organic chemicals of incredible variety, heaving under a lifeless sky and beating upon lifeless shores. Then at last an oilskinned droplet is formed with all the necessary ingredients, including the ability to duplicate itself. With no competitors this organism spreads like wildfire until checked by limitations in the food supply. Further progress is then limited until one of the organisms stumbles on the way, by means of chlorophyll, to produce its own food, using solar energy for photosynthesis."

Paleontologists keep using the term "stumbles onto" as an explanation of Life finding some new mechanism. But even allowing a sufficiency of coincidences (which could be, considering the numbers of organisms and spans of time involved) why would blind chance operate to increase complexity and to build higher levels of organization? What alien force does Life represent, that it swims upstream in disorder.

Teilhard's answer to this is sublime: Life's ultimate aim must be to reduce its dependence on the physical universe to the vanishing point—to evolve in the direction of superconsciousness, super organization, super communication, and (what he calls) super cephalization, with an eye to ultimate spiritualization. While it could not be said that there is any hint of Buddhism as such in his vision, there is a strong flavor of Teilhard's vision in Buddhism! Nirvana, so perplexing to the Western mind, is what Teilhard is talking about in the farthest reaches of his vision.

Certainly there is a flavor of the miraculous in the momentous advent of a molecule so large and complex

If Man manipulates and helps create his environment, has he not in effect put an end to evolution? Teilhard de Chardin answers no.

as to include self-reflecting patterns in a cybernetic "tail" which could produce a copy of itself from raw materials.

Still another miracle seems to exist in the fact that early plant life adopted a chlorophyll-photosynthesis mechanism for food production, in that it had the effect of putting free oxygen into the atmosphere. Was it blind chance and fantastic, isolated good luck that provided this necessary energy source for the animal life to come? If the whole animal world is merely parasitic on the vast tonnage of the earth's vegetable life, why was the parasite destined to evolve into more complex organizational patterns? In this light, is not the vegetable world simply a supporting platform, a step in the ladder of evolution?

And finally, if Life, quite apart from intellect, has sought to complicate itself more and more, where is it going? What is its aim?

Here is Teilhard's contribution.

First, he points out that there *is* a direction to Life, which explains a great deal about past evolution. The direction of Life is toward higher consciousness, he says. One begins to see right away how each step in the development of Life had this end in view. Complexity was necessary, and the complexity of lucky combinations of chemicals in the primordial soup came about too slowly. More important, gains could not be consolidated if all were left indefinitely to chance. Even though a given situation could recur with sufficient time, there would be no way to build on this good fortune unless some agency could assure its recurrence on a regular rather than a random basis. So, early in the game, at about the virus level (single large and incredibly complex molecules), the mechanism of reproduction came into play. Whether or not Life "stumbled onto" it is of no importance. What is important is that it retained and refined the trick (doing so without intellect on the part of its constituent organisms).

One view of the origin of reproduction (Bradley's) has it that the original one-celled organism would simply have kept growing larger except for the fact that it absorbed food from its surface. Its volume increased by the cube, while its surface increased by the square. This made feeding increasingly difficult, so the organism solved the problem by splitting in two, thus preserving the surface-to-volume ratio! Looked at this way, reproduction is a function of nutrition. Looked at another way, the original amoeba may still be alive, since death is the invention of multi-cellular life.

So reproduction was one of the early steps Life took to insure continuing (and increasing) complexity.

Very early, Life embarked on diversification, so that progress would not be the burden of one single strain, and thus take more time. More and more complex and stable reproducing molecules appeared and then Life brought on the cell. What this represents simply is the enclosing of the self-replicating molecule in a container holding the appropriate substances. Many regard the final development of the single cell from inorganic chemicals to be a more prodigious evolutionary feat than the development of Man from the single cell.

Temporary animals

More differentiation, more eons of time and then another step ("significant"?, "fortuitous"?, "miraculous"?) when clusters of cells first cooperated to form rudimentary and probably temporary multi-celled animals. One early form of this process involved a calling together of single cells in a feeding ground when the food was running short. Clustering, they formed a pillar which fell over of its own weight and became a crude slug capable of crawling. When a new feeding ground was found the slug disintegrated and its body cells went their individual ways until a famine treatened again. These early actions represented little more than a loose confederation of cells. But cell differentiation continued until highly specialized cells were part of the symbiosis—skin cells, muscle and nerve cells, etc., cells with no life of their own apart from their contribution to the organism.

Billions of days pass. Tough skins and teeth and bony shells and internal skeletons develop. Most important, the nerve cells increase the complexity of their organization and form a nervous system, which at long last, cephalizes, that is, assigns leadership of the system to a central control room, or brain. The head houses this control center and begins to preside over and edit data sent in by sense organs, highly specialized and differentiated cells, working together to form instruments of awareness. At the same time, this new headquarters for the nervous system dictates and coordinates muscular activity so the organism might take appropriate action for the acquisition of food or the destruction of, or escape from, enemies.

There are those who see in the development of man the end of evolution. Man is the un-specialized animal, the animal with a brain capable of abstract thinking and rational action, the animal which has come to dominate all other animals on the globe. If Man manipulates and helps create his environment, and equips himself with enormous eyes (telescopes) and sharp eyes (microscopes, infra-red night-vision and radar) a loud voice (amplified sound and broadcasting) and wings (airplanes) and titanic muscles (power machinery), has he not in effect put an end to evolution? Teilhard de Chardin says no. Man is significant, he believes, be-

The Church forbade Father Pierre to publish his works during his lifetime. But he makes a powerful case for both science and religion.

cause he is at that point in evolution where specialization is ended. It is as though Nature became aware that further experimentation with specialized animals was doomed to failure forever, since each strain either outsmarted itself through the development of some unpredictable vulnerability, or stabilized into a rut from which further progress was impossible. (The giant reptiles became vulnerable to slight climatic changes affecting their feeding areas, due to their excessive bulk; and the shark, which appeared before the mezozoic monsters, is so stable and stupid that it's unlikely he'll contribute much in the next 500 million years.)

Nature now produced or "stumbled onto" an animal different enough to make up for all the mistakes of evolution. Different enough to take possession of the earth and subjugate or eradicate every other species extant.

The main characteristic of this animal's difference is his reflective power. Here at last in the march of changes, is a development as significant as the reproduction mechanism, as symbiosis, as differentiation and specialization of cells. Now at last, no further need to experiment in species, at least on this planet. (Any of Nature's experiments from here on will be meddled with by man.) Evolution takes a sharp turn and rebounds on itself.

Teilhard believes the form this is taking is the heightening of consciousness through explosive reproduction and increased communication, to form a tight-knit "biosphere" through proliferation and eventually to form what he calls the "Noosphere" (or sphere of thought) which will resemble a single, highly conscious organism in the form of a membrane around the earth. He thinks the collectivization of mankind is inevitable, that it will happen politically at first, although he states that anything along the lines of government-imposed collectivization will never succeed, since the bonding agent between units of human individuality must be free choice guided by concern outside oneself and the maturity to care. (The opportunity and necessity for essential Christianity can be seen here.)

Sacrifice and salvation

Voluntary service in the context of this inner-motivated collectivization is perfect freedom, according to Father Pierre; self-sacrifice along these lines is self-salvation. ". . . by virtue of his acquirement of the gift of individual reflection," writes Teilhard in *The Future of Man*, "Man displays the extraordinary quality of being able to totalize himself collectively upon himself, thus

extending on a planetary scale the fundamental vital process which causes matter, under certain conditions, to organize itself in elements which are ever more complex physically, and psychologically ever more centrated. . . . Although in the prehuman stages of evolution the gradual growth of consciousness in animals does not appear to have had any appreciable effect on the course or speed of their zoological evolution, from the time of Man the evolutionary mechanism undergoes a radical change. For Man . . . not only becomes reflectively aware of the ontological current on which he is borne, but also gains control of certain of the springs of energy which dictate this advance: above all, collective springs, insofar as he consciously realizes the value, biological efficiency and creative nature of social organization; but also individual springs inasmuch as, through the collective work of science, he feels himself to be on the verge of acquiring the power of physico-chemical control of the operations of heredity and morphogenesis in the depths of his own being. . . . The terrestrial evolution of Life, following its main axis of homonisation, is not only completely altering the scale of its creations but is also entering an 'explosive' phase of an entirely new kind."

So much evidence of this explosive phase has appeared since Teilhard's death in 1955 that he emerges more and more as a prophet. One is inclined to think of him in connection with almost every news story. There is an intimate and revealing connection between such widely diverse news items as the changes in religion reflected in the Pope's travels and the Ecumenical Council, the civil rights movement in this country, the accelerating pace of automation and the whole cybernetics field, the inevitability of space travel, the newly emerging nations of the world. All these stories have to do with what Teilhard de Chardin believes is the emergence of the "Noosphere," the collectivization and social "cephalization" (formation of a head as the center of superconsciousness) of mankind. Thus evolution is seen, not as at an end, but as having taken a right-angle turn away from diversification and toward centration, with emphasis on rational thought and socially organized control of all future trends and experiments.

Personal agony

He makes a formidable case both for science and religion. This is no wishful thinker pulling the frayed ropes of tortured logic across the abyss between science and religion. Rather he is a man who, through considerable personal agony (the Church denied him publication of any of his works during his lifetime), has descended into the abyss and found it not bottomless. And he bids the stout of heart to follow him. What he has found is indeed awesome. But it's as inspiring as it is appalling. And as logical as it is mysterious.

SCIENCE ABC's

Snakes—the legless ones

The harmless and almost defenseless grass snake rolls over and plays dead when danger threatens. When the threat passes, it resumes its normal position and goes on its way.

SNAKES are reptiles and closely related to lizards. Their main features are the absence of limbs, a very long body, absence of ear openings and movable eyelids and a long cleft tongue. Snakes move by means of muscles which are fixed to the many ribs and pull the skin backwards and forwards in a kind of wave-motion. The scales on the under-surface grip the earth, branch, or whatever else the animal may be travelling over. Another method of moving is by twisting the body sideways in loops and wriggling along, pressing the body against projections in its path. The outer skin is shed periodically, usually in a single piece. The structure of the jaws is such that the reptile can eat its food whole.

We often hear that a snake "stings with its tongue." Actually the tongue is soft and harmless, and used in a very strange way—to smell with! Instead of sniffing with its nostrils, a snake catches smell particles on the darting tongue. This is then pulled inside, and the forked tip pressed into a special hollow in the roof of the mouth which is sensitive to smell. Snakes which are hungry or annoyed will dart the tongue rapidly to smell better. Some

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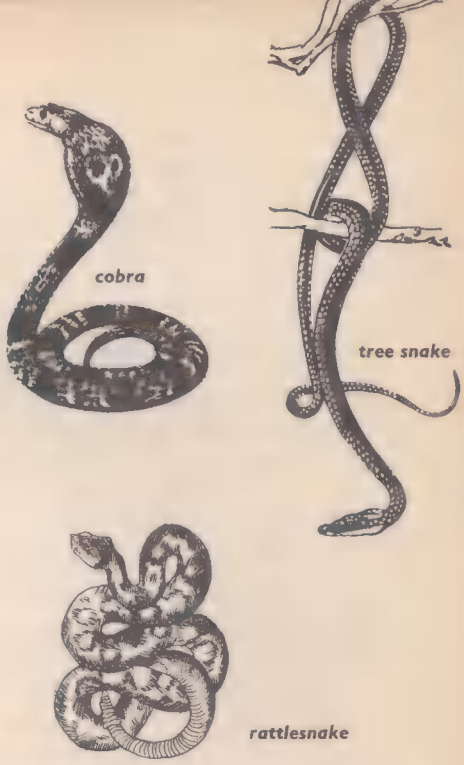
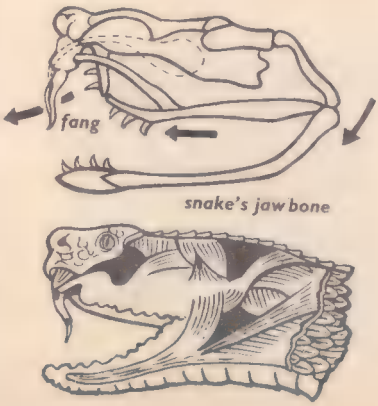
can find one another, or track their prey, in this most unusual way.

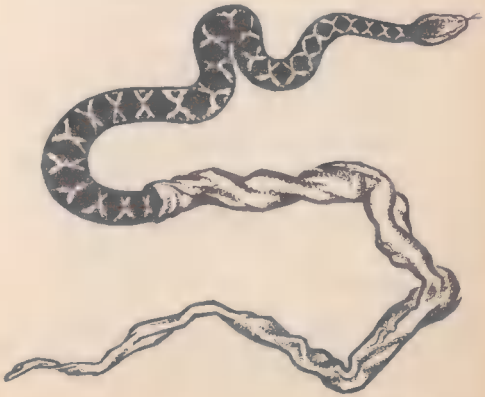
All snakes bite, but there is no such thing as a "sting." The sharp, curved teeth of non-venomous snakes may scratch or puncture the skin, but this injury is usually no worse than a sharp scratch from one of a cat's claws. A touch of disinfectant prevents infection. With venomous snakes like vipers and cobras, however, special teeth are used. These are the fangs in the upper jaw, which are hollow or grooved. The fang works like a doctor's hypodermic needle. In a viper it can be lifted and lowered by the action of the jawbones, which work like levers. It is a wonderful mechanism, although an unpleasant one. The venom is made in special glands, and when the snake strikes, these are squeezed so that poison is forced down the hollow teeth into the wound.

Snakes can swallow enormous meals because the jaw bones are not



Below left: Diagrams of the skull of a snake and the muscular structure of its head. Two unique features of a snake's head are the fangs that fold forward, and the hinged jawbone that allows the reptile to swallow a meal larger than itself. Below: Snake is casting or sloughing off its skin.





joined in front and the lower jaw is hinged at the back. Also, the skin of the face and body is very elastic. The halves of the lower jaw come apart at the tip to make the mouth much bigger. The snake pulls itself over the meal with a chewing action, and as the prey slides down the gullet, the mouth closes up behind. To prevent any choking the windpipe is pushed outside the mouth. At last the prey disappears and all we see is a bulge in the stomach, and this meal will do for many days, even weeks. Snakes have been known to fast for over a year without dying.

Food can vary from insects and worms to fair-sized pigs, antelopes and birds, according to the kind of snake. There are snakes that do much good in catching destructive animals, and, in some places, snakes are protected so that they can catch the rats and mice. In certain cases the prey is first killed by constriction, a habit of the big snakes. And snakes can be big. The longest snake in the South American anaconda can reach a length of 25 feet, and at 22 feet the reticulated python is a close runnerup. Such a monster could easily crush a man, but it is doubtful whether it could swallow him. The celebrated boa constrictor, by the way, is a very much smaller snake, rarely longer than 10 feet.

The principal venomous snakes of the U.S. are the rattlesnake and the copperhead. The rattle at the end of the rattlesnake's tail is formed from portions of the snake's skin that remain behind when the snake sheds its skin. Most snakes wave their tails when excited or afraid; in the rattler, this causes the well-known "hiss" of the rattle. The number of rattles on a rattler's tail (provided none have been lost) will tell how many times the rattler has shed its skin, but, since the rattler molts more than once a year, not how old it is.

An unusual kind of snake is the flying snake. It does not, of course, fly like a bird, but glides by flattening its body and diving through the air from branch to branch.

Snakes do not live only on land; there are many sea snakes, living almost entirely in the Indian Ocean, that spend nearly all of their time in the water. These feed only on fish, have flattened paddle-shaped tails, and nostrils which are closed by special flaps when they dive beneath the water. When on land they are almost helpless, since they are unable to crawl over the ground effortlessly like their very close relatives the land snakes.

How do you figure?

by John and Molly Daugherty

YOU'RE sitting on a plane between two men worth $1,000,000 each. Though you have only $1,000 the *average* assets of the three of you in a row are $667,000. Unfortunately, no amount of wishful thinking will put that extra $666,000 in your pocket!

Statistics can be helpful if interpreted wisely. But you are an individual. Don't let statistics scare you!

Try figuring out this math and statistics quiz:

1. In data about groups of people—I.Q. tests, weight and height tables, life expectancy figures, etc.—which of these "measures of central tendency" is affected by extreme scores?
   a. Median
   b. Mode
   c. Mean

2. If seven men meet at a convention, how many handshakes can take place without duplication?
   a. 7
   b. 14
   c. 21

3. How many committees of 4 can be made up from 7 men? (Some committees may have men who are on other committees, but no committee can have the same 4 men that any other has.)
   a. 28
   b. 35
   c. 49

4. If a student by diligent effort can get 5 more raw score points out of a possible 92 on a test, on which part of the percentile curve would the student have to be to benefit the most, i. e. to raise his percentile rank the highest?
   a. Near the bottom
   b. Near the middle
   c. Close to the top already

5. Simple correlation refers to the relationship between two factors which vary or change, such as weight and height or school marks and intelligence. Statistically, correlations can vary from —1.00 through 0 to +1.00. Which figure indicates the lowest correlation?
   a. +.90
   b. +.05
   c. —.70

6. A bag contains 10 marbles all the same size, but 4 marbles are green and 6, red. If you draw one of the marbles at random from the bag, what is the probability that you will draw a green marble?
   a. 4/10
   b. 5/10
   c. 6/10

7. Using the same bag of 4 green marbles and 6 red ones, what is the probability on repeated trials (returning the marble drawn each time) that you will succeed in drawing a green one on the first two trials but fail on the third?
   a. 2/10
   b. 144/1000
   c. 96/1000

8. In statistics, how data spreads out is usually shown by the standard deviation from the mean. If the standard devia-

tion on an I.Q. test were 20 points, approximately what percent of the group would be found in the span of 20 points below the mean to the 20 points above the mean?

a. 34 percent
b. 50 percent
c. 68 percent

9. Some standardized tests in achievement used in many schools report a student's score as a percentile band, such as 75-90. What percent of the time has this band of "confidence interval" of percentiles the probability of being correct?

a. About 68 percent of the time
b. About 59 percent of the time
c. About 90 percent of the time

10. In how many ways can you choose 3 books from 5 different books and arrange them in 3 spaces on your bookshelf?

a. 60
b. 18
c. 45

Answers:

1—c The mean, which is just an arithmetic average, is affected by extreme scores. The median is not affected. It is merely the midpoint of distribution. It's the point above which half the group lies and below which the other half lies. The mode is the score made most frequently. Sometimes it is quite different from the mean or median.

2—c 21. The first man can shake hands with 6 others. The second man can shake hands with 5 others, since he has already shaken hands with the first man. In like manner, the third man shakes hands with 4; the fourth, with 3; the fifth with 2, and the sixth, with 1. The total number of handshakes is the sum of 6, 5, 4, 3, 2, 1, which is 21.

3—b 35. The answer is the number of combinations that can be formed from 7 taken 4 at a time. By formula and factorial notation (!), the number of combinations (C) of n things taken r at a time equals the number of permutations (P) of n things taken r at a time divided by factorial r!

$$ {}_nC_r = \frac{{}_nP_r}{r!} = \frac{n!}{r!(n-r)!} = \frac{7!}{4!(7-4)!} = $$

$$ \frac{7\text{x}6\text{x}5\text{x}4\text{x}3\text{x}2\text{x}1}{(4\text{x}3\text{x}2\text{x}1)\ (3\text{x}2\text{x}1)} = \frac{7\text{x}6\text{x}5\text{x}4}{4\text{x}3\text{x}2\text{x}1} = 35 $$

4—b Near the middle. When a percentile curve is made from normally distributed data, the *ogive* smooth curve is not a straight line. The scores, grouped in small intervals and expressed in cumulative percents increasing from the bottom to the top, are plotted against percentiles. The slope of the curve rises sharply for the first 20 percentile points and then is nearly a straight line until about the 80th. From the 80th to the 100th percentile the curve rises sharply again. A 5-point gain near the bottom increases standing only about 4 percentiles; near the middle, about 16 percentiles.

5—b Because it is closest to zero, +.05. The correlation −.70 signifies a negative correlation, illustrated by a quantity which decreases when some other factor increases. (Example: the colder the day, the more fuel you would burn to heat your house.) A positive correlation like +.90 may be expected between two different but well-matched arithmetic tests taken by a class of students. Actually, intelligence doesn't always cor-

relate with school grades, because of the other factors present, such as motivation, interest, effort, etc.

6—a 4/10. The probability depends upon the number of ways your drawing a green marble can happen, as well as the number of ways it can fail. For any given trial, if m is the number of green marbles and n, the number of red, the formula for the probability that you will draw a green one is

$$P = \frac{m}{m+n} = \frac{4}{4+6} = \frac{4}{10}.$$ The probability that you will fail to draw a green one is

$$\frac{n}{m+n} = \frac{6}{4+6} = \frac{6}{10}$$

7—c 96/1000. For a single drawing the probability of drawing a green marble is 4/10 and of not drawing it, 6/10. With three drawings, the probability is the product of three probabilities (two successes and one failure) or

$$\left(\frac{4}{10}\right) \times \left(\frac{4}{10}\right) \times \left(\frac{6}{10}\right) = \frac{96}{1000}.$$

If order of the trials doesn't matter, then the probability becomes three times greater, 288/1000.

8—c Approximately 2/3rds of the group—68 p. c. This holds true for reasonably large groups when the data approaches normal curve distribution. Besides the standard deviation, the quartile deviation is sometimes used. The middle two quartiles would include 50 percent of the group, one quartile below and one above the median.

9—a About 68 percent of the time. This procedure recognizes that a pinpointed percentile score is unjustified. Test scores are not perfectly accurate or constant. They may vary with different forms of the same test. Reporting test scores as percentile bands is one of the modern improvements in testing in the past decade.

10—a In 60 ways. The first space on the shelf can be filled five ways; the second, four; and the third, three. Using the multiplication principle for permutations, the answer is 5x4x3= 60. By formula and factorial notation (!), the number of permutations (P) of n things taken r at a time is

$${}_nP_r = \frac{n!}{(n-r)!} = \frac{5!}{(5-3)!} = \frac{5x4x3x2x1}{2x1} = 60.$$

Score Yourself:

9—10 right—You're in the top percentile!

4— 7 right—Somebody has to have a mean score.

0— 3 right—The results of this test do not correlate highly with intelligence.

"I knew this 500,000-stage rocket would get us to the moon."

Headaches and teeth

Your article on headaches ("New attack on headaches," Nov. '64) must certainly have had many seriously interested readers. It concerns a disability which afflicts many of us.

But one etiological factor, a serious one and one that can often be successfully eliminated with beneficial results, was not mentioned. This is temperomandibular joint dysfunctions due to dental malformations or defects and some other dental disorders.

I have known patients who have suffered with migrainous attacks for as long as ten years (and who have gone through the usual gamut of therapy). Finally they are asked by an examining dentist if they have ever had headaches of any sort. The dentist sees the obvious (it usually is). With correction the patients can become completely free of headaches. It seems your readers might be interested to know this very definite cause of very serious headaches.

I happened to pick up your magazine at the newsstand when I saw your cover headline on headaches, something in which I have long been interested. I found your book varied, diverting, and relaxing.

EMILE W. SALVO, D.D.S.
Natchez, Miss.

Displaced workers

Your article "Jobs of the future" (Nov. '64) is astounding. What a hodge podge of metaphysical terminology. You contend that displaced workers will be absorbed into other fields. Fields such as what? Garbage picking, panhandling, and "welfare working."

Of course the government will train them for other jobs, jobs that are as nonexistent as the ones they lost. All you can do is expostulate about jobs that don't exist.

FRANK MORROW
New York N. Y.

Did the red tide do it?

Concerning "Plague of Florida and California" (Nov. '64):

The "dino" in dinoflagellates has nothing to do with the "dino" in dinosaurs. It is derived from the Greek "dinos"—whirling around, which is what the beasties accomplish with their flagellae.

And how could, or did, the "red tide" kill the pilot whale in the Sea World Oceanarium? A non-poisonous species could conceivably use up the oxygen in the water. This is not likely, or else the 14 surviving yellowtail would have suffocated too. But supposing all the oxygen had been used up, why would that be fatal to an air-breathing mammal?

If, on the other hand, the invaders were toxic, why would their poison affect a warm-blooded whale? Warm-blooded animals are, I believe, immune even to *Gymnodinium breve* (not *brevis*, please; the things are halfway between plants and animals but not between masculine and neu-

ter) except, possibly, when they swallow it in concentrated form, and it couldn't have been concentrated, or else the yellow-tail, etc. And besides the article quotes an authority on this very May 1964 "red tide": "There is no evidence that this species was toxic."

I know it wasn't the butler. But what is the solution to the underwater whodunit?

ERNST BEHRENDT
Pound Ridge, N. Y.

The author replies

Mr. Behrendt was absolutely right about the "dino" in dinoflagellates. As far as the pilot whale is concerned, all the scientists I checked with said that they had heard or read that the management at the Sea World Oceanarium claimed the pilot whale died from the red tide.

Gymnodinium brevis stands as is, irrespective of its "masculinity" or its neuter. Dr. Oguri of U.S.C. said that in assigning the names to organisms, proper grammar is not always observed. Once the name is assigned by the scientists, that's it.

In regard to the fish dying from non-toxic red tide. It has long been noted by scientists that fish die from lack of oxygen in the water. The research Director of the Department of Fish and Game, Terminal Island, California, said that they had suffocation die offs at Santa Cruz and also at Terminal Island. Oxygen levels during a full bloom of red tide go down to 0. Dr. Clyde ZoBell of Scripps Institution of Oceanography at La Jolla, California, told me that "During and particularly in the wake of plankton blooms, the water often becomes anaerobic due to decomposition processes, and hydrogen sulfide may be produced. This concentration may be created by non-toxic dinoflagellates as well as by toxic ones. More marine fish are probably killed by these processes resulting from non-toxic plankton organisms than from those that produce specific toxins."

The other 14 yellow-tail might not have survived if they hadn't taken steps to clear the tank of "red tide" immediately.

NELLIE B. SLATON
Los Angeles, Calif.

The compleat proofreader

"The Compleat Camel" is an article in your Nov. '64 issue. We have checked all of our dictionaries and can find no word spelled "compleat." Please let us know if this was a mistake in proofreading. Our class would appreciate hearing from you.

CINDY REGGA
Orlando, Fla.

The word "compleat" is not in most modern dictionaries. It is an archaic English spelling. Why use it? Well, in 1653, the English author Isaak Walton wrote "The Compleat Angler." What the book's title really meant was, "Here's everything you need to know about the joys of fishing." In modern times, the word "compleat" has come to mean "having everything," "fully equipped." Certainly that meaning applies to the camel.—Ed.

(Late Science News, continued from page 7)

WHAT CAUSES COLDS? You probably thought all those colds you have been getting this winter have been triggered by changes in the weather. Scientific experiments did not support this view but a British medical researcher believes your unscientific idea might have been correct all along. Sir Christopher H. Andrews thinks that weather changes cause enough stress in the body to upset its ability to hold in check the cold viruses that are always present.

LIFE GETS AROUND. In Nov. 1963 a new volcanic island was formed off the southwestern coast of Iceland. Scientists visiting the island a year later found many life forms, including a moth, a mussel and a whole host of bacteria.

UNDERPASSES FOR DEER. California authorities have become alarmed at the large number of auto accidents involving deer. Not only are deer killed but drivers' lives are endangered and cars damaged. Authorities are constructing culverts under busy throughfares that cross heavily travelled deer migration routes.

QUOTE OF THE MONTH: "Technology is not an irrepressible force of nature to which we must meekly submit. It is nothing but the artifacts fashioned by modern man to increase his powers of mind and body. Marvelous as they are we must not let ourselves be overawed by these artifacts. They certainly do not dictate how we should use them; nor by their mere existence do they authorize actions that were not anteriorly lawful." Vice. Adm. Hyman Rickover.

100-year-old hoax

THE meteorite fragment (right) contains clear evidence of advanced forms of life. It fell to earth in a shower of meteorites at Orgueil, France, on May 14, 1864. Shortly afterward, it was sealed in a glass jar at the Musee d'Histoire Naturelle, Montauban, France, remaining there until 1962. Then the jar was opened and the fragments arrived at the University of Chicago a few months later.

Prof. Edward Anders, an authority on the origin and age of meteorites, was the first to examine the fragment.

"I almost fell off my chair," Anders recalls. The meteorite definitely contained seeds of plants, pieces of coal and protein material. He rushed into a corridor with a magnifying glass to show colleagues his discovery: seed capsules—of a type Anders could not identify—firmly imbedded in the black meteoritic matrix.

But all the excitement gave way to smiles after the fragment was returned to France, where one of the seeds was definitely identified as belonging to a reed found near Orgueil. The other seemed to resemble another known plant.

Prof. Anders and five other scientists began tracking down what really happened to the meteorite. Their conclusion: the life in the meteorite probably came from a 19th century prankster.

Prof. Anders and his associates found the fragment had been contaminated with a "water-soluble protein of animal origin"—such as glue.

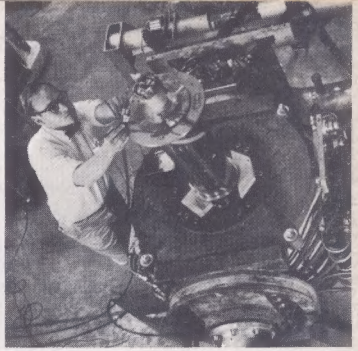
The scientists decided that before it was obtained by the museum, the stone had been moistened to a paste, after which the foreign objects were moulded into it. The stone was then glued and dried out.

However, it was reasoned, this would have destroyed the crust created when the meteorite heated up during its flight through the earth's atmosphere. Sure enough, the crust did differ in important respects from other meteorite samples. But it was a "remarkably good imitation" of genuine crust, the scientists acknowledged.

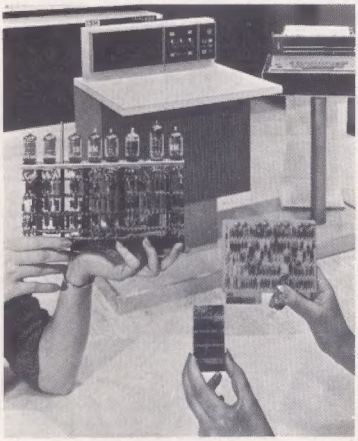
Who was the prankster? His identity is probably lost forever. But Anders says, "A friend of mine is convinced he must have been an Englishman just visiting France. He reasons that only an Englishman could pull a practical joke and wait patiently until after his death for it to be discovered."

in this issue . . .

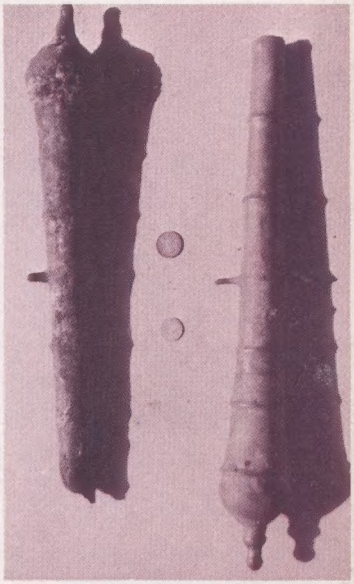
This little snake is more afraid of you than you are of it. It plays dead when it sees you. Other snakes aren't so timid. For the lowdown on snakes, see page 92.



This device doesn't look like the familiar horseshoe magnet, but it is a magnet nonetheless, the most powerful man-made magnet in the world. See page 11 for details.



This a family portrait, showing the basic components of three generations of computers. For an understandable explanation of what computers can do, see page 61.



Diving for sunken treasure has given way to underwater archaeology—but the fascination of antique cannons and gold coins remains the same. See story beginning on page 48.

At a radio observatory in Armenia, Russia's top astronomers met to ponder whether we are getting signals from another civilization. Page 8.

When one scientist looked at this he almost fell off his chair. It is a meteorite with a seed in it. Did the seed come from space? For the answer to this puzzling scientific detective story, see the inside front cover.